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BEFORE THE TWENTY-FIRST COMMUNIST PARTY CONGRESS OF THE SOVIET UNION

Our socialist motherland is experiencing significant days, full of great political and economic development. The thoughts of millions of Soviet people turn now to the Twenty-first Congress of the Communist Party, to be opened on January 27, 1959. The Congress will endorse the grand program of the fight for Communism. Inspiring vistas of a further growth and development of all branches of the national economy, as outlined in the theses of Comrade N. S. Khrushchev's report to the Twenty-first Congress of the CPSU, "Planned figures for the development of the national economy of the USSR for 1959-1965," gave rise to a new creative activity among workers in the fight to attain these goals.

The theses of Comrade N. S. Khrushchev's report to the Twenty-first Congress of the CPSU are being discussed throughout the whole country. To mark the occasion of the Congress, socialist competition is spreading.

Soviet metallurgists have been given one of the foremost parts to play in the fulfillment of the enormous tasks set out for the next seven-year period.

At all the metallurgical works in our country the workers compete in fulfilling and surpassing the production quota of each establishment, shop and plant, and for raising productive efficiency and improving the quality of the production.

The personnel of the Magnitogorsk Metallurgical Combine honorably filled the obligations undertaken on the occasion of the Twenty-first Congress of the CPSU: the state plan for 1958 was completed ahead of schedule and tens of thousands of tons of ore, sinter, pig iron, steel and rolled product were produced over and above the planned amount.

The workers and technical personnel of the "Zaporozhstal" Works undertook the obligations and fulfilled the production plan for sinter by December 25, and for pig iron, steel, and rolled product by December 26; they produced thousands of tons of metal over and above the planned quota, achieved a lower production cost than provided in the plan and saved over 16 million rubles; and they increased the productive efficiency by 1% as compared with the planned figure.

The steel melters of that Works wrote a letter to the Magnitogorsk steel melters in which they called for an increase in the output of steel per m^2 of the hearth area. In their letter they say: "We can announce with pride that we have achieved the highest annual output of open-hearth furnaces in the Soviet Union and in the world; the output of large-capacity furnaces constituted 10.4 tons per m^2 of the hearth area".

On the initiative of the steel melters of No 1 open-hearth shop at the Nizhne-Tagil Metallurgical Combine, M. Safronov, M. Morogov, K. Doshchatov, and A. Valeev, an All-Union challenge among the steel melters was started. In their letter to the Magnitogorsk steel melters, A. Melnikov, I. Semenov, M. Zinurov and G. Ogloblya, the Nizhne-Tagil steel melters write:

"The program set out by the Party for great undertakings signifies the beginning of a new period in the development of our country—the period of large-scale building of the communist society....We, metallurgists, aspire to be in the vanguard of the struggle to build communism and we shall spare no pains in our work for a further development of the iron and steel industry. On taking stock of our reserves we decided to produce an additional 2000 tons of steel before the opening of the Congress. Comrades, let us announce an All-Union challenge among the steel melters. We shall share our experience in our work on exploiting new productive reserves for fulfilling the grand tasks set out by the Communist Party ahead of schedule."

The team undertook to produce 3 extra tons of steel per shift per team member and to have produced hundreds of tons of steel above the plan by the opening day of the Congress.

The Magnitogorsk steel melters, A. Melnikov, I. Semenov, M. Zinurov, and G. Ogloblya, to whom the Nizhne-Tagil steel melters wrote, declared their furnace "a Plant of Communist Shock-Labor" and undertook to extend their knowledge and to study in order to fulfil the tasks put before them honorably. "We decidedly undertake the task of living and working like communists," they write in their reply to the Nizhne-Tagil steel melters.

The appeal of the Nizhne-Tagil steel melters met with a wide response at many metallurgical works. The steel melters of the Andreev Taganrog Metallurgical Works decided to start a general review of their productivity reserves. Competing to mark the occasion of the Twenty-first Congress in a befitting manner, every member of steel melter Tereshchenko's team decided to contribute to the effort in the utilization of internal productivity reserves.

The competition for the title "The Team of Communist Labor" is under way at the metallurgical works. At the Dzerzhinskii Works, the Komsomol-Youth team from one of the blast furnaces where the team

leader is P. P. Lygun, a Deputy to the Supreme Soviet of the USSR and a member of the Central Committee of the Metallurgical Industry Workers' Union, decided to undertake the obligation which it will fulfil like a sacred oath. "We realize that for the victory of communism a rise in productive efficiency is the most important factor. Therefore, our first commandment will be: every day, every hour and every minute to fight with perseverance for rising productive efficiency and for the maximum utilization of productive capacities.

"To economize in small things and big—this is the rule for every one of us. We promise to reduce the cost of every ton of pig iron by 2 rubles and to save 8000 tons of coke, 1000 tons of ore, and 2000 tons of limestone by the end of the year.

"Each member of the team is an active innovator and strives to master additional related trades.

"All members of our team study in evening schools, technical schools, and institutes. We shall go on studying and incessantly increasing our knowledge in order to become competent members of the communist society.

"The team will have the patronage of the students of one of the schools and will help and advise them and take part in their industrial training.

"In our everyday life, we shall piously observe the laws of communist morality and shall be an example to young people".

The team is composed of: Yu. Maidanik, A. Skorobogatov, B. Burkhovets, V. Kolomoets, N. Kochetkov, A. Golyak, P. Dudnik, N. Pokhil, and foreman, V. Pilnik.

In 1958, the personnel of this furnace produced thousands of tons of pig iron over and above the planned output and saved thousands of tons of coke and metallic additions. Operating the furnace with oxygen-enriched blast, the team achieved the best ratio of the furnace useful volume to daily output in the Ukraine (0.59-0.62). The team dispensed with the services of the crane operator. All the members of the team mastered the technique of crane operation, passed the examination and were given crane-operator's licenses.

This year, the Komsomol-Youth team, composed of the foremen Khabarov, Ryabtsev, Gornostaev, and Romanov, the gas operator Zhilin, the first furnace attendant Karpeta, the scale-car operator Karaimov and others at a blast furnace at the Magnitogorsk Metallurgical Combine, produced many thousands of tons of pig iron over and above the plan and achieved a ratio of the furnace useful volume to daily output equal to 0.592. The young blast-furnace workers declare: "The time has come when every man should look anew on his life and begin communist competition."

In its undertaking, the team declared: "The personnel of our Komsomol furnace decided to work in communist fashion and to make our furnace an advance unit in the Seven-Year Plan. We have decided unanimously to produce several thousands tons of pig iron with a sulfur content below 0.035 , in excess of the production quota before the end of the year. In the next year, we will undertake to save the State one and a half million rubles by making economics in coke and raw materials. All of us to a man shall study continuously, and shall obtain secondary and then higher education. Even now, among the personnel of the blast furnace there are many operators with engineer's degrees and technician's diplomas.

High communist labor discipline, irreproachable behavior in everyday life, and active participation in social work—these are our commandments."

The team of steel melter Comrade Kaelo ("Zaporozhstal" Works) has undertaken as follows: every day to exceed by 10 tons the shift production quota; in the course of the Seven-Year Plan every member of the team is to acquire secondary education, and those who have already completed secondary school are to acquire higher education—this to be done without interrupting the work in industry. To put an end to the survivals of the past: drunkenness, hooliganism and unworthy behavior in life.

The team undertook to bring the steel output to 10.4 tons per m^2 of the hearth area, to extend the furnace campaign to 560 heats and to save 2 kg of fuel per ton of steel. These undertakings are being successfully fulfilled.

The youth team of the medium-section mill of the Novosibirsk Metallurgical Works led by team leader, T. Petrov has undertaken as follows: "To produce some hundreds of tons of high-quality rolled steel in excess of the production quota in the time before the Twenty-first Congress of the CPSU. Each member of the team undertakes to become an innovator, and to master all the trades required for the operation of the mill. In the course of four years all are to acquire secondary or secondary technical education. To fight drunkenness and foul language ruthlessly. To study literature, art and music. Every member of the team is to achieve a standard in some type of sport".

The mill operators, V. Trubnikov and V. Vinokurov, members of the team, are students at the All-Union Correspondence Polytechnical Institute; mill operator, N. Shcherbakov, assistant, N. Yakovlev, and operator, N. Vasil'ev, study at the evening school for young working people.

The Comsomol-Youth team of the plate-rolling mill of the "Serp i molot" Works led by team leader, V. Dyuzhev has written in its undertaking: "Entering the competition for the right to be called 'The Team of Communist Labor', we have decided to behave like communists at work, during studies and in everyday life; to fulfil in 5 instead of 6 hours the tasks alloted for the shift; to produce 95 % first-grade product; each member

of the team is to submit at least one innovation in the course of a year, to improve knowledge constantly; all members are to join the auxiliary militia team to fight for the establishment of culture and order; to take patronage of the 8th form of the 411th Moscow school and to inculcate work and a respect for working trades upon the students."

As a result of the extensive socialist competition on the occasion of the Twenty-first Congress of the CPSU, metallurgists have successfully fulfilled the state production plan for the ten months of 1958.

In separate production branches, the production quota has been met as follows:

Pig iron	101%
Steel	102%
Rolled product	103%
Steel tubes	102%

These achievements would be impossible without the high conscientiousness and creative efforts of the vast ranks of Soviet metallurgists. Under the guidance of the Communist Party our nation enters a new important period in its development—the period of large-scale building of a communist society.

AUTOMATION OF PRODUCTION PROCESSES IN THE IRON AND STEEL INDUSTRY OF THE USSR.

A. V. Leskov

"In 1959-1965 the construction of large mechanized and automated metallurgical plants, provided with modern equipment, will be carried out" (From the theses of Comrade N. S. Khrushchev's speech at the Twenty-first Congress of the CPSU)

The planned figures for the development of the national economy of the USSR for 1959-1965 envisage the extensive introduction of automation in the production processes in industry. It is necessary to carry out a gradual transition from the automation of separate machines and operations to the automation of production processes, plants and finally whole factories. Without the completion of these tasks, set out in the theses of N. S. Khrushchev's speech at the Twenty-first Congress of the CPSU, it is impossible to ensure technical progress in the national economy, to increase productivity, to improve working conditions and to achieve a rise in the living standards of the Soviet people.

The work on the automation of production processes in the iron and steel industry was started even before the Second World War, but they acquired a particularly big impetus after the Twentieth Congress of the CPSU. At present, in the USSR, more than 90% of the pig iron and steel is produced in mechanized and automated blast-furnaces and open-hearth furnaces, but the telecontrol and telemetry are still only in the development and design stage. In this new field, the metallurgists are lagging behind the power engineers.

Owing to the automation introduced so far at the blast furnaces, open-hearth furnaces and heating furnaces, it was possible to increase the output of these units by at least 8-10% and to achieve almost as high a saving in fuel. The automation of the rolling mill resulted in a 15% output increase. Thanks to the automation of blast, open-hearth, and heating furnaces, the State obtained millions of tons of ferrous metals without the construction of new plants, and saved huge quantities of fuel, the working conditions being considerably improved at the same time.

The introduction of automation in the production processes in the iron and steel industry permits a reduction of the operating personnel of 25%, an increase in the output by 10-15% and a reduction in the cost of products of almost 20%.

In 1959-1965, it is imperative to carry out a number of changes with respect to a further automation of the production processes in the iron and steel industry; the advanced techniques of leading establishments should be more widely popularized and the new methods, which are still in experimental stage, of the automation of industrial processes should be extensively introduced.

Let us examine the principal changes to be made in the basic plants of metallurgical works.

Blast-furnace production. At the blast furnaces of the USSR, the charging of the furnace, the control of the flow rate, the humidity and temperature of the blast, the control of the temperature conditions of the blast-furnace stoves and the control of the elevated gas pressure in the furnace top have been automated. The automation of the loading and weighing of the charge, as carried out by the Kuznetsk Metallurgical Combine, makes it possible to perform this arduous work in a dusty atmosphere and at high temperature without the necessity for manual labor.

A comparison of the extent of the automation of blast furnaces abroad and in the USSR shows that the instrumentation of the blast furnaces in West European countries and in the USA is at the same level as in the USSR. But,

as is known, the ratio of the blast furnace useful volume to daily output is better by 20-25% in the USSR than in the USA and other capitalist countries. Better automation schemes for the blast furnace process which are now being developed will make it possible to improve the utilization of the blast furnaces, to increase the output and to improve the quality of pig iron.

The principal problems in the further automation of blast furnace production are the improvement of the automation schemes for the loading and weighing of the charge, the development of a method of automatic control of the level and shape of the blast furnace stock, the automation and mechanization of the operations on servicing the blast furnace and the establishment of an integrated scheme for the automation of the blast furnace operation based on the process parameters. At present, the Central Laboratory of Automation, the Ukrainian Institute of Metals and other organizations are working out the solutions to these complex technical problems.

The experiments at the Arovstal Works on the automatic control of blast furnace operation based on the total heat balance are very interesting and promising. At one of the furnaces at this Works, members of the L'vov Polytechnical Institute installed a computer which evaluates continuously, by means of the formulas proposed by Prof. V. A. Sorokin, the parameters which define the blast furnace process and which can be used for the automatic control of the process.

Steelmaking. In the open-hearth furnaces of the Soviet Union the valve change, the pressure in the furnace, the ratio fuel : air, the temperature and input rate of the gas and fuel oil have been automated. The determination of temperature by means of immersion thermocouples and the automatic recording of this temperature by special instruments is being introduced. With regard to the automation of open-hearth furnaces, the Soviet Union is not inferior to the USA and other leading capitalist countries and is much ahead of them with regard to the operating efficiency of the furnaces and the output of steel per m^2 of the hearth area.

The main tasks in the further automation of open-hearth production are the improvement of existing systems of automatic control in which the application of oxygen for the intensification of the combustion and technological process would be taken into account, and the development of integrated schemes for automatic control of the steelmaking process. At present, analytical expressions for various technological processes, which expressions are necessary for the design and operation of computers, are being studied. The first experimental prototypes of such computers have been constructed.

An automatic system of controlling the thermal regime of open-hearth furnaces based on the determination of the rate of heating the air checkers according to the periods of the heat, has been developed and tested at the Magnitogorsk Metallurgical Combine. The system developed ensures a complete control of the thermal regime in the course of the heat in accordance with the requirements of the technological process without the participation of the steel melter.

The department of furnace heat engineering at the Dnepropetrovsk Metallurgical Institute has developed a project for a "thinking" open-hearth furnace. The integrated scheme of the automation of this furnace envisages the operation of the furnace without the intervention of the steel melter. At No. 1 open-hearth furnace at the "Zaporozhstal" Works, similar preliminary experiments have been carried out: the steel melter only watches how the foreset schedule of the mechanized charging of the furnace is adhered to; the automatic instruments themselves reduce the fuel and air flow rate when the charge materials have been introduced and the hot metal has been poured in and then vary the thermal regime depending on the conditions of the heat.

Together with the open-hearth furnace operators, the electric steel melters also work on the problems of automation. An apparatus, developed by the employees of the "Électropech' " Trust and the "Élektrosila" Works, for the electromagnetic stirring of the bath is being introduced at the electric furnaces of the "Dneprospetstal' " Works. A very complex research program has been started on the automatic determination of the chemical composition of the metal and slag in the course of the heat, on the automation of the labor-consuming operations of slag removal from the furnace and the fettling of the furnace after the tapping.

The converter process is the least automated in the USSR and abroad. In view of the fact that all converter steel should be made with the use of oxygen, the problem of the automation of the converter oxygen feed in conformity with the reactions taking place in the converter has become extremely urgent.

Within the next few years the continuous casting of steel, which has been proved at several works to be satisfactory and which makes possible a substantial improvement in working conditions and the elimination of mold yards, stripping sections and blooming mills, will be extensively introduced at Soviet steel works. In this connection, the design organizations envisage the automation of the steel casting process, the control of the steel level in the crystallizer, the control of the secondary cooling in conformity with the speed of ingot extraction, etc.

Rolled steel and tube production. In the field of the automation of rolling mills, and, in particular, as regards the mechanization and the automation of the finishing lines and cleaning machines, the USSR is still lagging behind the most advanced capitalist countries. The automation of the equipment and the rolling mills has so far been carried out only at three blooming mills, fifteen section mills, seven tube mills and a few plate rolling mills. The automation of these mills is not comprehensive. At the blooming mills of the Magnitogorsk and the Kuznetsk Metallurgical Com-

bines, the operation of the ingot buggies, receiving and delivery roller tables, screw-down equipment, main drives, working and run-out roller tables has been automated. These arrangements have increased the output of the blooming mills and improved the working conditions of the operators.

Work has been started on developing systems for the automation of blooming and slabbing mills by means of perforated cards. At present, automation is being introduced at existing steel rolling and tube mills, while new mills, incorporating most advanced automation, are being designed. The mill operators of the Magnitogorsk Metallurgical Combine are in the lead.

It is imperative that a complete automation of rolling mills, so far not realized either in the USSR or abroad, should be achieved. The design of all mills to be constructed should incorporate comprehensive automation. It is also necessary to speed up work on the automation of the rolled-material dimension control based on the absorption of x-rays and the radiation of radioactive isotopes, to introduce extensively instruments for the automatic control of the thickness of the rolled piece in the course of rolling, the thickness of the tin coating on steel sheets, etc.
should make use of television equipment by means of which one can operate the mechanisms of charging the steel into and delivering it from the reheating furnaces of the mill from one central place.

Hardware production. The multioperational character of hardware production requires an integrated mechanization and automation of technological processes in order to combine separate operations into mechanized production lines or units. At present, continuous production lines for the cold stamping of bolts and nuts have been set up; a continuous production line for wood screws has been developed.

Nine continuous lines for the production of bolts are operating at the Magnitogorsk Metallurgical Combine at present. At the Odessa Rope Works, eight furnaces and three small baths for pickling thin wire are automated. At the Stalingrad Wire and Rope Works, continuous lines for thermal treatment, pickling and galvanizing, combined into one unit, are now being introduced. At the Nizhne-Dneprovsk Works, an integrated process line for annealing and galvanizing telegraph and armored wires is operating. At the Khartsyzsk and the Stalingrad Works, continuous machines for patenting, preparing the wire for drawing and galvanizing are being mastered. The personnel of the Leningrad Rolled Steel Wire and Rope Works, in cooperation with the employees of the Institute of Physics, Academy of Sciences, Latvian SSR, have developed a more reliable and convenient method of marking cold-rolled strip by means of radioactive isotopes instead of the tag system.

It must be acknowledged that the mechanization and automation of hardware production at several works in the USA and in some other countries is at a more advanced stage than in the USSR. It is necessary, first of all, to concentrate all our efforts on the comprehensive mechanization and automation of separate production lines and machines by providing them with instrumentation for the automatic control and inspection of semi-finished and finished products. Then, taking into account the feasibility of a narrow specialization of hardware factories for one-type production, we must enter the next stage: the construction of fully automated factories.

The prospective problems of complex automation of production processes in the iron and steel industry are being worked out by the leading design institutes: Gipromez, Stal'proekt, Giprokoks and other organizations. The "Énergochermet" Trust with its Central Laboratory of Automation, Project and Design Bureau, instrument factories and industrial engineering factories, carries out research and experimental work, and the installation and maintainance of instruments and equipment produced at the works.

Specialized instrumentation and automation shops have been set up at the iron and steel works. The experienced personnel at these shops not only assist the central specialized organization in the solution of their difficult problems but also very frequently work out and introduce automation at their establishments on their own.

The productive capacities of the instrument-manufacturing industry are expanding and the experience and experimental facilities at industrial establishments, design bureaus and scientific research institutes are developing . New improved designs of more accurate sensitive high-speed instruments, which are reliable in operation, are being developed.

Every year, more and more great scientists, project engineers, researchers and production engineers as well as leading workers are attracted to the work on the automation of production processes. This wide range of work provides a reliable guarantee of a successful fulfillment of the tasks which are envisaged by the planning figures for the development of the national economy of the USSR in 1959-1965 in the field of the automation of production processes of the iron and steel industry.

THE REDUCTION OF SULFUR CONTENT IN PIG IRON IN THE COURSE OF THE BLAST-FURNACE PROCESS

I. I. Korobov

Director of the Petrovskii Works

A relatively high sulfur content in Donets coke, and a high silicon content and a very low aluminum content in the barren rock of the Krivoi Rog ores present Ukrainian metallurgists with a very serious problem: to find an effective technical means of fighting the harmful effects of sulfur in the blast-furnace process. The solution of this problem will make it possible to utilize extensive productive potentialities of the blast-furnace plants. The blast-furnace operators should request the operators of coking plants and coal-purification plants to get a further reduction in the sulfur content in coke. This, however, does not exclude the fight against the harmful effect of sulfur in the blast furnace.

V. G. Voskoboinikov,* V. I. Loginov,† I. P. Semik,‡ and others in articles published in the journal "Stal' ", on the study of the behavior of sulfur in the blast-furnace process, the distribution of sulfur between the slag and pig iron, and the conditions under which sulfur passes from the pig iron into the slag, recommend that acid slags should be made and that the pig iron should be desulfurized outside the blast furnace. This conclusion cannot be regarded as economical under existing conditions. It is doubtful if better technical and economic results in the operation of the blast furnace with acid slags (RO: SiO_2 = 0.9-0.8 or less) under the conditions existing in the South can be attained. While devoting enough attention to the problem of the behavior of sulfur in the blast-furnace process and to laboratory investigations of the transition process of sulfur into slag, V. G. Voskoboinikov, V. I. Loginov, and I. P. Semik overlook other important phenomena taking place in the blast furnace and exerting a decisive influence on the redistribution of sulfur between pig iron, slag and gas, and on the final result of the blast-furnace process.

What is involved if acid slags are used under the present conditions at the Ukrainian blast furnaces when the Krivoi Rog ores, sinter and fluxes are not properly ground and screened, the tuyères operate irregularly and the temperature of the blast is relatively low (700-800°C)? It means that the furnace will operate continuously on an irregular basis. Under these conditions, it would be a great mistake to change the operation to acid slags and to the desulfurization of pig iron outside the blast furnace and, at the same time, to expect an increase in output.

The presence of large (100-150 mm or more) lumps of high-silicon ores, sinter and flux in the charge for recommended acid slags will, as experience in the operation of the blast furnaces has shown, cause a more extensive direct reduction of iron oxides to metallic iron (this reaction already being very high), and a sharp drop in temperature in the zone of slag formation and below this zone; in other words it causes the whole lower part of the blast furnace to cool and will definitely result not in a decreased but in an increased coke consumption and in a fall in the output of the blast furnace. Owing to the poor viscosity of primary slags at a low temperature and the prolonged period of slag formation, the smooth running of the furnace will be upset. The losses of pig iron in the form of slag in the runners and ladles will increase and the work of the operating personnel at the furnace will become very difficult.

It is known that the temperature of the lower part of the furnace (bosh, tuyére zone and hearth) and the temperature of the slag and pig iron in the hearth depend mainly on the temperature and the heat of fusion of the primary and secondary slags. Acid slags have an extremely low temperature and heat of fusion and when we take into account the fact that the low aluminum content in many present-day slags of the blast furnaces in the South (below 6 or even 5%) gives an additional drop in the fusion temperature, then the temperature of the slag will be 100 °C or more lower than at present.

At such a temperature, the distribution of sulfur between the slag and pig iron will be unsatisfactory and the chemical composition of the slag will hardly have any effect on the desulfurization of the pig iron. Even at a high degree of sulfur volatilization from the blast furnace the sulfur content in the pig iron will remain high.

In addition, the zone of temperatures above 950 °C will extend during operation with acid slags (RO: SiO_2 = 0.95-0.8 or less), since the heat distribution in the heat balance for the zones will alter. The part of the slag heat which is not absorbed by the slag will be used up for a further heating of the materials in the higher zones in the furnace and will result in an early beginning of slag formation. The extension of the temperature range above 950°C toward the top of the furnace will also cause a higher degree of direct reduction of iron oxide to metallic iron and that will result in a general cooling down of the furnace. To compensate for the heat loss in the total heat balance of the blast furnace, it will be necessary to increase the coke input and raise the temperature of the blast. The

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* Stal' No. 7, 1955.

† Stal' No. 2, 1955.

‡ Stal' No. 4, 1949.

situation will be still worse if the ore, sinter and flux, constituting the charge, are badly prepared.

This conclusion is confirmed by experience at blast furnaces operated with acid slags under the conditions existing in the South. In 1939, by way of an experiment, one of the blast furnaces of the Petrovskii Works was operated for a few months with so-called "ultra-acid slags" of the ratio RO: SO_2 = 0.94, or slightly less when open-hearth pig iron of a rather low manganese content was produced. Unfortunately, no records of these operations have been preserved, but it is known that the furnace was running irregularly all the time. The slags had a high iron content, they were extremely cold and heavy, and a large amount of scrap remained in the ladles and runners. The losses of metallic iron in the form of scrap and in the slag constituted about 5% of the weight of pig iron. At the same time, apart from the acid slag, there were no other causes of furnace irregularities.

On the basis of all the above considerations, one can propose the following practical measures which should reduce the harmful effect of sulfur in the blast furnace process to a considerable degree.

1. To crush the ores, sinter and fluxes thoroughly, down to the maximum size 35-40 mm for ore and sinter, and 50 mm for fluxes. To exclude fine fraction from all charge materials (1.5-2 mm). To improve the preparation of ores, fluxes and coke for the blast furnace process, and to attain the pest possible reducibility of the prepared ores and the fusibility of the sinter. To this category the development of the production of fluxed sinter and sinter with artificial gangue also belongs. These measures will make it possible to reduce coke consumption considerably and, consequently, to reduce the sulfur content in the charge.

2. To raise the temperature of the blast to the maximum possible (to 1000-1100 °C at the existing blast furnace stoves in the very near future, and then, after the modernization of the stoves, to 1300°C or more). This too will reduce coke consumption considerably and, in addition, it will raise the temperature in the furnace hearth slightly thus improving the distribution coefficient of sulfur between slag and pig iron.

3. To eliminate the nonuniformity which still exists in tuyères operation (different temperature and rates of air blast in different tuyères owing to poor mixing of cold and hot air in the hot air mains) and which results in an uneven descent of the charge and, hence, leads to a more extensive direct reduction of iron oxides to metallic iron thus lowering the temperature of the lower part of the furnace and impairing the process of the desulfurization of pig iron.

4. To mix the fluxes with the ore portion of the charge well in the course of charging the blast furnace and to add dolomitized limestone in the amount calculated for obtaining not less than 5.5% magnesia in the final slag.

5. To find technical means of regulating the temperature of the slag in the blast-furnace hearth because the temperature of the slag in the hearth plays the main part in the desulfurization. This means should be oxygen which could be introduced through one of the cinder notches or through a special opening for taking oxygen to the center of the hearth by means of a cooled movable nozzle. In this way, it will be possible to raise the temperature of the slag up to the necessary limit with the object of obtaining sulfur-free pig iron.

All investigations carried out in the USSR and abroad, on the distribution of sulfur between pig iron and slag confirm the decisive effect of the temperature on the distribution coefficient of sulfur between the slag and the pig iron, and confirm the possibility of obtaining sulfur-free pig iron when slags are considerably more acid than these with which the Ukrainian furnaces operate at present. Thus, the additional heating of the slag in the hearth by means of oxygen opens great possibilities for the operation of blast furnaces with acid slags provided that there is a proper and thorough preparation of the charge, high temperature of the blast, even functioning of the tuyères, good mixing of the flux with the ore portion of the charge during the charging of the blast furnace and the presence of not less than 5.5% MgO. Under those conditions, the percentage amount of flux in the charge will be reduced and favorable conditions will be provided for the sulfur volatilization. The reduction in the percentage weight of slag, inevitable at that composition, will have little practical effect on the pig iron desulfurization process in the blast furnace.

The problem of a possible lowering of the slag basicity when all the proposed steps are taken can be solved only with an experimental blast-furnace operation which will probably be carried out in the next year or two. And the desulfurization outside the blast furnace should be regarded as an occasional (and temporary, at that) means of correcting the quality of the converter and casting pig irons when the temperature in the blast furnace drops accidentally. As to the proposal by V. G. Voskoboinikov, V. I. Loginov and others for a special operation with acid slag and the tapping of low-temperature pig iron of high sulfur content and the subsequent desulfurization of the pig iron outside the blast furnace, one must consider these proposals to be uneconomical.

UTILIZATION OF THE WATER FROM SLAG GRANULATION FOR COOLING THE BLAST FURNACE

Cand. Tech. Sci. T. T. Nesterenko

Donets Industrial Institute

The life of the cooling equipment of blast furnaces depends to a great extent on the properties of the cooling water. Water used at the works in Donbas is of 8-20° N temporary hardness and has a high content on mineral substances.

The temperature of the outgoing water must not be allowed to rise above 45°C because the precipitation of the salts, constituting temporary hardness, causes a reduction in the internal cross-sectional area of the cooler tube and limits the rate of water flow into the cooler.

Vapor bubbles form on the walls of the box-type cooling equipment. At the same time, the salts which constitute a temporary hardness (calcium and magnesium carbonates and bicarbonates) and, partly, salts which constitute permanent hardness (calcium and magnesium sulfates) are deposited on the walls of the cooler, thus impairing the heat transfer and causing a rapid rise in the temperature of the cooler walls. The suspended matter which amounts to 15-200 mg/ liter in the cooling water has the same effect.

In summer months, the temperature of the cooling water for the blast furnace at the Almaznaya Works reached 15°N and this made the maintenance of the cooling equipment difficult. Up to 50 air tuyères burned through in a month. For extending the service life and improving their performance, the coolers were washed twice a month with a 10% solution of hydrochloric acid.

The author carried out an investigation with the object of exploring the possibility of utilizing the water from slag granulation for cooling the blast furnace. It was found that supplementary feed water to the recycle, from which the water for cooling the blast furnace was taken, was hard (10-20 °N temporary hardness). But the outgoing water from the slag granulation was soft (2-4° °N temporary hardness). For these reasons, the author proposed that the outgoing water from the slag granulation should be used for cooling the blast furnace.

Without any change in the existing water mains, the water from the granulation of blast-furnace slag was introduced into the recycle of the water supply, and the supplementary water feed from the Severnyi Donets river and from the No.1 water reservoir was discontinued. Immediately after the water from the granulation was introduced, the water-main filters at the blast furnace became blocked with carbonate deposit in the form of plates 0.5-4 mm thick and up to 1cm² in area. Every two hours during the next two weeks, the filters had to be cleaned of the deposits which accumulated in the course of many years operation and were dislodged by the softened water from the granulation.

Owing to the use of water from the granulation of blast furnace slag for cooling the blast furnace, the regular washing of the coolers with hydrochloric acid solution was eliminated, the temperature drop increased and the cooling water consumption was reduced by half. The life of the air and slag tuyères was considerably extended and the burning through ceased almost completely. When the tuyères were replaced, it was found that they were worn out due to the eroding action of descending coke particles, the walls of the tuyères mouth being reduced to 1mm thickness.

In the summer period the temperature of the inlet water fluctuated between 28 and 35 °C. The temperature of the outlet water increased at times to 60 °C. No deposit of scale in the cooling instruments was observed.

Water from the slag granulation has been employed for cooling the blast furnace for the past six years. The determination of the hardness of this water showed that its temporary hardness does not increase. During the granulation of blast furnace slag, calcium and magnesium carbonates and bicarbonates precipitate out of the water. The remaining small amounts (up to 4 °N) do not precipitate out even at boiling temperature. Therefore, granulation water may be used for cooling metallurgical furnaces. But the permanent hardness of the granulation water increases. This increase can be explained by the dissolution of calcium and magnesium sulfates.

TIGHTENING THE CHARGING HOPPER

V. P. Emel'yanov

Magnitogorsk Metallurgical Combine

The joint between the receiving hopper and the hopper of the revolving distributer was not tight at the blast furnaces of the Magnitogorsk Metallurgical Combine. When the charge fell from the bells, the dust pene-t penetrated through gaps and settled on the furnace-top platform and on the equipment. Therefore, continous maintenance and regular cleaning of the furnace-top platform was necessary.

On the proposal of D. S. Gormakov, a labyrinth seal of the charging hoppers at the blast furnaces was adopted (Figure). The labyrinth is formed by ring plates welded to the receiving hopper and to the distributor hopper. A ring, a strip shaped into a cylinder and a cone are welded to the receiving hopper; a shell, a ring and sealing cones, which form a 10mm gap between the labyrinth projections of the receiving hopper, are welded to the distributor hopper.

As a result of the adoption of this type of seal, the amount of dust thrown out into the gap between the receiving hopper and the distributor hopper was reduced substantially.

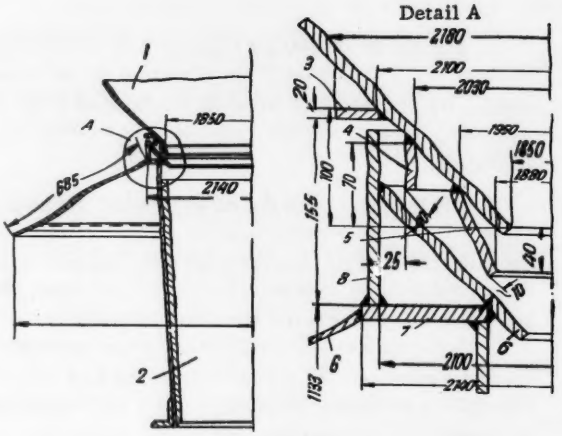

Fig. Seal of the charging hopper: 1) hopper of the revolving distributor; 2) receiving hopper; 3) ring; 4) strip; 5) cone; 6) sealing cones; 7) shell; 8) ring.

THE EFFECT OF SOME TECHNOLOGICAL FACTORS ON THE QUALITY OF STRUCTURAL STEEL

K. K. Prokhorenko, N. P. Shchekin, and S. M. Sergienko

At the Kulebaki Metallurgical Works, 30KhN3A, 35KhGSA structural steels, and other steels are used for the manufacture of railroad tires and rings for gears. The most common defects of these steels are longitudinal cracks on the surface and gas blowholes under the ingot skin and deep inside the ingot, fractures on the finished rolled rings and large nonmetallic inclusions which are exposed during the machining of the tires or cutting of the gear teeth.

The steel is made in basic open-hearth furnaces fired with oil fuel. Compressed air is used for atomizing the oil. Freshly roasted lime, dry iron ore and chamotte chips are used instead of bauxite, with the object of preventing the steel from absorbing hydrogen. The steel is run from the furnace by a double runner into two ladles. It is bottom poured into big-end-up, twelve-sided molds with hot tops; an ingot weighs 2.5 tons. At the time the tests were carried out, the fountains and the bottom runners were made of chamotte brick manufactured at the Works.

A special investigation was carried out at the Works with the object of determining and eliminating the causes of hot cracks, gas blowholes, and large nonmetallic inclusions in the ingots for tires and structural steels.

Gas blowholes. Several causes of the formation of gas blowholes in ingots are known. If the steel is not properly deoxidized, blowholes appear in the ingot because during the solidification of steel, reactions between the dissolved oxygen and carbon take place and gaseous carbon monoxide is formed. To prevent these reactions, the steel should be deoxidized as thoroughly as possible. However, it was shown by the investigation (Fig 1) that it is not possible to eliminate the gas blowholes in the ingot merely by increasing the amount of aluminum added during the deoxidation.

If the deoxidized period of the heat in the furnace is extended, the loss in burning of the deoxidizers in particular aluminum, becomes greater and, hence, the hydrogen content in the steel is higher and this promotes the formation of gas blowholes in ingots. It follows that the longer the deoxidation period, the larger is the number of gas blowholes in the ingots (Fig. 2)

With the object of reducing the time of deoxidation, tests were carried out on the complete deoxidation of steel in the ladle. Owing to the replacement of the preliminary deoxidation of steel with 12%-ferrosilicon by deoxidation in the ladle, the amount of the ingots affected with gas blowholes fell from 4.66% to 3.55% (results from 23 heats).

During the investigation of the specimens from rejected steel ingots, signs of skin folds in the region of gas blowholes were detected. This fact suggests that the formation of gas blowholes in ingots depends also on the skin folds. With the object of explaining this assumption, some pieces of the skin, which were picked out by means of a steel hook from the mold when it was being filled, were subjected to metallographic analysis. The skin consisted of solid steel full of gas blowholes and large particles of nonmetallic inclusions. As a result of the large number of gas blowholes and large nonmetallic inclusions, the density of the skin (4.5-6.5 g/cm^3) is less than that of steel and, therefore, the skin floats on the surface of liquid steel.

When it is folded, the skin gets inside the ingot and, thus, introduces the gas blowholes and nonmetallic inclusions which it contains. Therefore, for the elimination of the formation of gas blowholes in ingots, skin folds must be prevented. This can be achieved by increasing the rate of filling the mold. The data given in Table 1 indicate that an increase in the rate of pouring contributes greatly to a reduction in the percentage of ingots affected by gas blowholes. Since no skin forms on the surface of steel

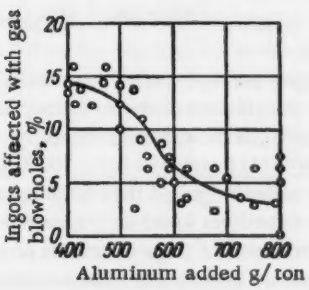

Fig. 1. The effect of aluminum on the formation of gas blowholes in ingots.

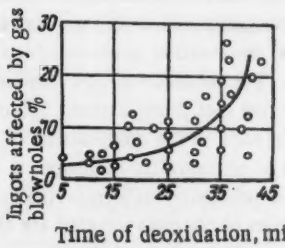

Fig. 2. The effect of the time of deoxidation on the formation of gas blowholes in ingots.

TABLE 1. The Effect of the Rate of Filling the Mold on the Formation of Gas Blowholes in Ingots

Method of pouring	Rate of filling the mold, mm/min	Number of ingots cast	Amount of ingots with gas blowholes, %
Bottom-poured	250-180	385	26.1
"	360-260	210	6.43
"	520-370	110	4.35
"	600-450	110	0.7
Top-poured through tun dish	650-550	210	0.0

TABLE 2. The Effect of the Pouring Rate on the Contamination of 30KhN3A Steel with Nonmetallic Inclusions

Method of pouring	Rate of filling the mold, mm/min	Number of rings inspected	Amount of rings with nonmetallic inclusions, %	
			mean	maximum
Bottom-poured	250-180	953	12.5	22.5
"	360-260	1019	10.9	15.6
"	520-370	482	8.5	13.2
"	600-450	350	3.7	5.5
Top-poured through tun dish	650-550	225	0.1	0.3

when small ingots are top-poured, top pouring combined with a correct deoxidation of the steel may help to completely eliminate gas blowholes in ingots.

Nonmetallic inclusions. During the machining of the rolled rings and tires large nonmetallic inclusions are sometimes found on the surface and this results in the rejection of large quantities of steel products.

Investigations showed that those nonmetallic inclusions are usually slag particles which rise to the surface of liquid steel when the mold is being filled. The chemical composition of such a slag is similar to the composition of the nonmetallic inclusions which are separated out from the steel when specimens are dissolved electrolytically. Hence, it may be assumed that this slag consists in the main of the steel deoxidation products which rise up in the liquid steel. The presence of calcium oxide (1.5-4.5%) in the slag indicates that there is about 10% of furnace slag. Some difference in the composition of this slag from the composition of nonmetallic inclusions is due also to the presence of erosion materials from the mold refractories.

The particles of the risen-up slag are retained in the skin which form on the surface of liquid steel. The folded skin introduces this slag into the body of the ingot. It may be assumed that when the ingot is top poured, the contamination of the surface and of the underlying layer

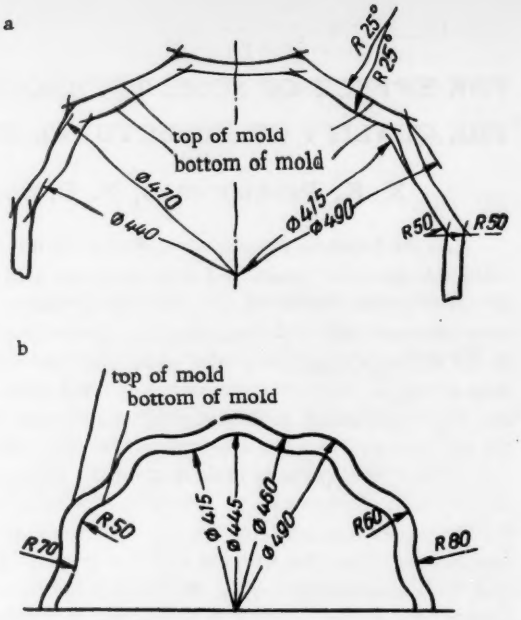

Fig. 3. Mold cross section. a) Old shape b) improved shape

with large nonmetallic inclusions–the rising slag–takes place in the same way as the formation of scabs.

Thus, the origin of large nonmetallic inclusions and of gas blowholes in bottom-poured structural-steel ingots is the same. Observations indicate that nonmetallic inclusions are frequently found in the places where gas blowholes occur in the ingot. By etching in acid the specimens of steel from rejected rings it was possible to detect the presence of the skin in the places where large nonmetallic inclusions occurred.

Hence, in order to prevent defective rings and tires due to the presence of large nonmetallic inclusions, the steel should be poured at a higher rate and without skin folds (Table 2).

It is seen from Table 2 that an increase in the pouring rate reduces the contamination of ingots with large nonmetallic inclusions.

Investigations showed that the surface of the bottom-poured ingots with a pouring rate of up to 300mm/min is relatively clean. But, at the same time, nonmetallic inclusions occur inside the ingot. Large skin folds are usually absent if the pouring rate is increased to 500 mm/min, but the surface of the ingot is contaminated with nonmetallic inclusions. These inclusions occur at a fairly small depth and are easily removed when the billets and rings are machined. When the rate of filling the mold is increased to 700-800 mm/min, the surface and the internal zones of the ingot are free from nonmetallic inclusions.

It must be pointed out that neither the method of deoxidation nor the amount of aluminum added into the ladle for the deoxidation of steel (if amount of aluminum is between 300 and 1200 g/ton) affect the degree of the

Table 3. The Effect of the Rate of Filling the Mold on the Amount of Rejected Ingots of 30KhN3A Steel With Longitudinal Cracks

Rate of filling the mold	Number of ingots cast	Amount of ingots rejected owing to longitudinal cracks, %
250-180	385	2.5
360-260	210	5.74
520-370	110	17.4

TABLE 4. The Effect of the Shape of the Internal Surface of the Mold on the Formation of Longitudinal Cracks on Ingots

Rate of filling the mold mm/min	Mold design	Number of ingots cast	Amount of ingots with longitudinal cracks, %
250-350	Old	476	5.9
520-370	"	128	17.4
250-350	New	391	0.1
600-450	"	310	3.2

contamination of ingots with large nonmetallic inclusions which are detected during the machining of rings and tires. Thus, the replacement of the preliminary deoxidation of steel in the furnace by the deoxidation in the ladle, and the replacement of aluminum by silicocalcium or AMS alloys with the same method of pouring did not reduce the percentage of defective rings and tires rejected because of nonmetallic inclusions.

Cracks. The increase in the pouring rate in the course of the investigation resulted in an increase in the percentage of defective ingots with longitudinal cracks (Table 3).

As a result of prolonged observations, it was established that longitudinal cracks occur in the majority of cases on the ingot corners. With the object of preventing the formation of longitudinal cracks, the cross section of the ingot was slightly altered by increasing the curvature of the sides and increasing the difference between the circumscribed and inscribed circle for the cross section (Fig. 3). The comparison of ingots of various cross sections showed that the reduction of the curvature radius of the edges to below 50 mm with an unchanged curvature of the sides has an injurious effect on the quality of ingots, owing to the appearance of an increased number of cracks and fractures.

The introduction of molds with an internal surface of a modified shape (Fig.3,b) resulted in a reduction in the number of ingots with hot longitudinal cracks and made it possible to increase the pouring rate of steel (Table 4). It should be pointed out that the shape of the molds while helping to reduce the number of ingots with hot longitudinal cracks does not make it possible to eliminate this defect completely.

As is seen from Table 5, there were no hot longitudinal cracks on the surface of the ingots which were top poured through the tun dish.

Whereas the bottom-poured ingots are affected with longitudinal cracks but are almost completely free from transverse cracks, the top-pouring of ingots, while permitting the elimination of longitudinal cracks, enhances the formation of transverse hanger cracks.

The pouring of steel through the tun dishes ensures a uniform crystallization of the ingot at the walls of the mold owing to a low ferrostatic pressure in the tun dish. The uniform crystallization of the ingot near the walls of the mold is one of the main causes for the low number of longitudinal cracks in ingots which are cast by this method.

Measurements of the temperature of the steel in the furnace before the tapping, by means of the platinum-platinorhodium immersion thermocouples, showed that the minimum amount of defective ingots with cracks is obtained when the temperature of 30KhN3A steel is within 1620-1630 °C. At a temperature of 1675-1685 °C, approximately 50% of all ingots had longitudinal cracks.

The defects in structural-steel billets due to fissures, which form on the surface of the billets during forging, are closely related to the cracks. The cause of fissure formation may be longitudinal cracks (which are invisible to the eye), situated on the surface of the ingots and covered with a layer of scale, as well as internal cracks not extending to the surface of the ingot. This is confirmed by the fact that it is possible to use the same means for the prevention of longitudinal cracks and

TABLE 5. The Effect of the Method of Pouring 30KhN3A Steel on the Amount of Rejected Ingots with Longitudinal Cracks

Method of steel pouring	Steel poured, tons	Rate of filling the molds, mm/min	Amount of ingots rejected owing to longitudinal cracks, %
Bottom-poured into the molds of the new shape	275	650-450	3.2
Top-poured through the tun dish into molds of the old shape	160	650-550	0

fissures. Thus, the introduction of new wave-shaped molds resulted in a reduction in the amount of rings with fissures from 2.1 to 0.7% (on the basis of 867 rings inspected).

The formation of fissures may also be due to the presence of "cold" cracks on the ingot surface. A retarded cooling of the ingots of 30KhN3A steel assists in the prevention of the formation of "cold" cracks on the ingot surface and, hence, the amount of defective billets with fissures appearing during forging is reduced.

IMPROVED LINING OF ELECTRIC FURNACES

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* Head of the electric steelmaking plant.

** Senior furnace foreman, Kuznetsk Metallurgical Combine

One of the most important ways of increasing the output of electric furnaces is to extend the service life of their lining. In this respect, the electrometallurgists at the KMC have done a considerable amount of work and have achieved certain successes. The life of the walls of the furnaces in the electric steelmaking plant has been increasing with the successive introduction of a number of improvements: the adoption of iron inserts for the construction of walls of magnesite brick; the introduction of ordinary chrome-magnesite bricks from the Satka Works; the use of large-size, tapering, chrome-magnesite, unfired bricks in iron frames made at the KMC.

Since 1953, large-size, unfired, chrome-magnesite, tapering bricks in iron frames, which enclose the bricks on three sides, have been used for furnace walls. The bricks are of 420 kg/cm^2 mechanical strength, 12.5% porosity and contain 68.3% Mg and 10.4% Cr_2O_3.

This brick is laid radially, on edge, with its wide end toward the reference layer (hearth bottom). The reference brick layer consists of standard magnesite bricks ("facing"), laid on flat in one course. The reference brick course of the walls on the side of the second phase (under the supports), where the furnace walls are subject to more rapid erosion, is laid from ordinary chrome-magnesite brick, so that if the walls in this section become prematurely eroded or crumble, it is still possible to keep the furnace in operation for a long time without shutting it down for repairs. The chrome-magnesite bricks in frames are laid with their narrow end toward the center of the furnace. Each brick course forms a compact ring which fits well into the circular shell of the furnace.

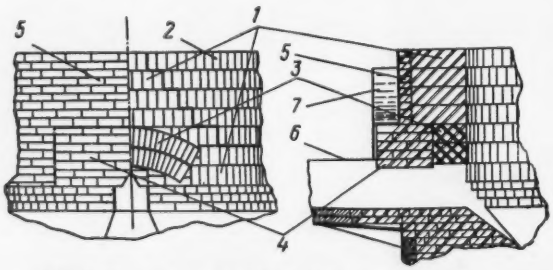

Fig. 1. Construction of the walls of electric furnaces: 1) 430 mm chrome-magnesite bricks; 2) 300 mm chrome-magnesite bricks; 3) tap hole arch; 4) thick facing; 5) wall facing; 6) tapping spout; 7) water-cooled arch.

The iron frames assist in binding the bricks together. The first two brick courses of the wall, above the level of the slag, are laid with 430 mm long bricks and the remaining courses are laid with 300 mm long bricks (Fig.1). The walls above the arch of the tap hole are laid stepwise to the very top with 430 mm brick (shown by the thick line in Fig.1).

Table 1 gives the data on the durability of walls and roofs of electric furnaces.

The increase in the life of walls from 1953 is due mainly to the change in the construction of the arch of the tap hole as well as to a better maintence of the tap hole. The cause of shutting down the furnace for cold repairs was usually the crumbling of the walls above the tap hole, while in remaining parts of the furnace the walls were still adequately thick.

The tap hole arches, tested previously, were in the form of a semicircle and consisted of three rows of chrome-magnesite bricks; under the arch and above the tap hole, a small block made of magnesite powder and

TABLE 1. Life of Walls and Roofs of Electric Furnaces

Life (in number of heats)	Year						
	1953	1954	1955	1956	1957	May 1, 1957 to April 1, 1958	in 5 months of 1958
Walls	54	69	67	87	112	140*	164
Roofs	68	108	102	135	119	—	127

* Life of walls after the rebuilding of the furnace shell.

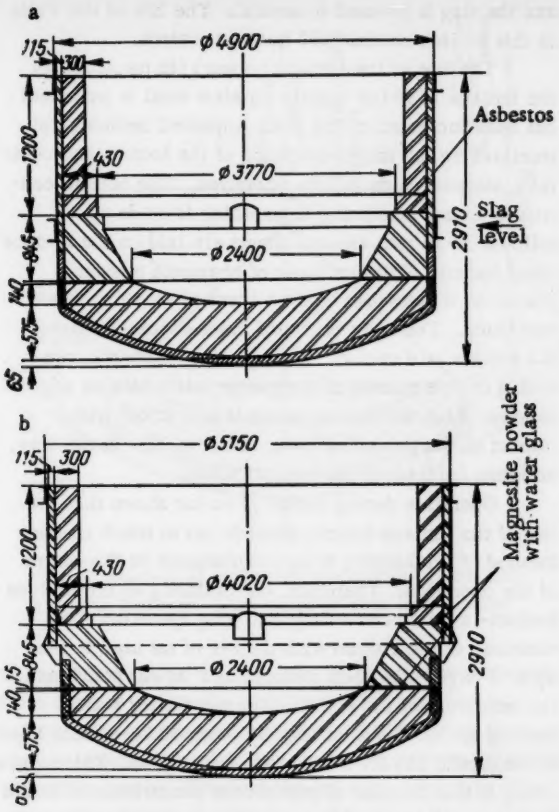

Fig. 2. Shell and lining of electric furnaces before (a) and after (b) the modernization

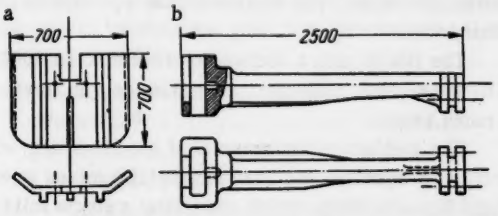

Fig. 3. Scraper (a) and bar (b) for cleaning the furnace bottom.

water glass was placed; later on, an attempt was made to make an arch of variously shaped chrome-magnesite bricks or packed blocks of magnesite powder, tar and pitch. However, these constructions of the arches were found unsatisfactory in service.

At present, the arch of the tap holes is of spherical shape and is laid with two courses of 300 mm long, tapering, heat-resistant chrome-magnesite bricks (on edge) with 1.5 mm thick iron strips inserted between the bricks. The particular feature of the arch and back-wall brickwork is the thick facing layer as shown in Fig. 1.

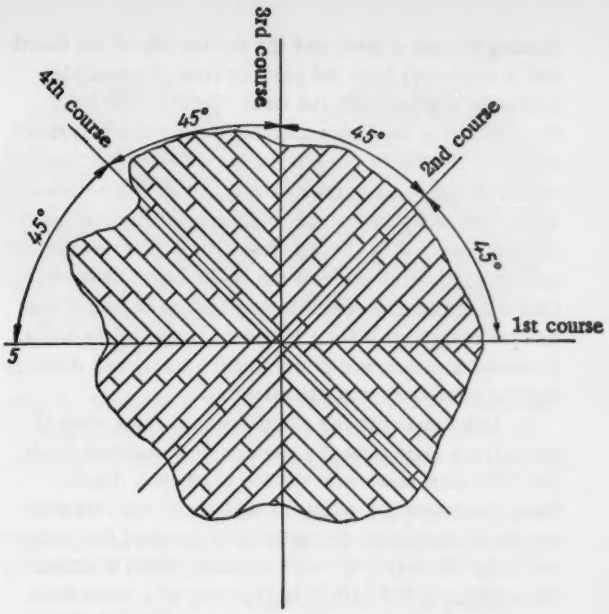

Fig. 4. Details of furnace-bottom brickwork

This facing takes part of the pressure of the furnace-wall brickwork which is above the arch and relieves the load on the arch to a great extent.

As the lining of the furnace becomes eroded, the thickness of the arch decreases and, at the same time, the pressure on the arch of the walls made of chrome-magnesite bricks in iron frames above the arch is lessened (since the thickness of the walls is reduced too). Therefore, the arch does not break down in spite of extensive erosion.

After the heat has been tapped, the tap hole is covered from outside (on the tapping spout side) with dolomite and from inside (when the furnace is tilted) with magnesite powder moistened with a water solution of sodium silicate. Such a fettling keeps the walls above the tap hole in good condition. In this way, the need for shutting down the furnace for repairs because of the collaspe or premature erosion of the walls above the tap hole was completely eliminated.

With the object of extending the life of the walls even further, on the suggestion of Monastyrskii, Fudkomaz and Shtepa, the shell of the furnace was increased by 250 mm (Fig. 2) during the major overhaul in April, 1957. Owing to this alteration, the inclination angle of the walls increased by 10° and, hence, the walls could be fettled more thoroughly, their base could be made thicker and the internal surface to the wall could be pushed 125 mm further away from the electrode arcs. This, in turn, reduced the erosion of the furnace walls.

It is known that the service life of furnace walls depends not only on the furnace design, the grade of the steel produced and the method of steelmaking, but to a considerable extent also on the condition of the hearth bottom and banks. The melting of the steel on a deep bottom and thin banks has a negative effect on the

heating process of steel and the service life of the hearth and is dangerous from the point of view of a possible erosion of the lining by the steel. On the other hand, the melting of steel on a shallow hearth has a negative effect on the life of the furnace walls, since then the walls are subjected to the direct action of high-temperature steel and slag and are subject to intense erosion in the slag zone. It is obvious, therefore, how important the normal (optimum) shape of the bottom and the banks, (and the maintenance of this shape in the course of the furnace operation) is for a long service life of the walls. A careful maintenance of the furnace lining and thorough fettling after each heat are essential.

One furnace in the electric steelmaking plant is specialized mainly for the production of stainless steels (60-70%) from scrap with the use of oxygen. Under these circumstances, when the blowing of the bath with oxygen is completed the bottom and banks of the furnaces are under the action of very hot metal which is cooled by the addition to the bath of heavy scrap of a given steel (preferably in the form of one or two slabs). In spite of that, the normal shape of the bottom and banks is distorted: the bath becomes deeper and the walls thinner.

To repair the lining after the heat has been tapped, the damaged places on the bottom and banks are thoroughly fettled with a well blended mixture, prepared beforehand, which consists of roasted dolomite, fine magnesite powder and fine chromium ore (in the ratio 1:1:2). As a rule, the bottom is fettled as the furnace is returning to its horizontal position after the heat has been tapped (so called fettling "on the incline"). The furnace walls and their zone of extensive erosion at the slag level are fettled with magnesite powder mixed with water glass during the charging of the furnace (the furnace is charged by means of charging boxes). Owing to this method of maintenance, the life of the walls of this furnace has reached 200 heats or more, and the life of the bottom, which previously was 800 heats for stainless steel production, has now exceeded 2000 heats.

The bottom and the banks of the electric furnace, which is specialized for the production of ball-bearing steel, accumulate the refining slag and, therefore, the level of the liquid steel in the furnace rises gradually. If appropriate steps are not taken, a zone of intensified erosion forms on the walls at the slag level and the walls begin to crumble. In such a case, the furnace is usually used for a heat of another steel grade, in the production of which the bottom and the banks are subjected to a greater thermal load (e.g., 12KhN3A, OKhNIM and other steels). After such a heat has been tapped, the upper layers of the bottom and banks are in a softened condition. This softened material is removed with a special scraper by means of a charging machine (Fig. 3) and then only the zone of intensified erosion in the walls is fettled (as a rule, during the charging) with magnesite powder moistened with an aqueous solution of water glass (mixed with coal-tar pitch). In this way, the level of the steel and the slag is lowered to normal. The life of the walls in this furnace reaches 150 heats at present.

The life of the furnace bottoms (in particular of the furnace in which mainly stainless steel is produced) has been increased owing to an improved technique of steelmaking, an improved lining of the bottom and careful maintenance during the operation. The bottom consists of a heat-insulating layer which is made up as follows: 8-10 mm asbestos sheets are laid on the furnace-shell bottom, a 20 mm layer of chamotte powder is placed on it, and then again a layer of asbestos 30-40 mm thick. Then one course of foam chamotte bricks (65 mm) is laid on flat. A magnesite brickwork consisting of five courses of magnesite bricks laid on edge follows. Each successive course is laid at 45° with respect to the preceding lower one (Fig. 4). In this way, no joints coincide in the vertical plane.

Operation during recent years has shown that the life of the furnace bottom depends not so much on the method of bricklaying as on maintenance in the course of the operation. Therefore, the ramming of the furnace bottom—a labor-consuming and long operation (the ramming of the bottom with the use of tar used to take up to 3 days)—has been discontinued at our plant, and the brickwork of the bottom is covered after a short heating to 100°C with a slightly rammed 30-40 mm layer of magnesite powder mixed with water glass. This rammed lining is laid in order to prevent the penetration of liquid steel into the joints of the brickwork during the first heats. The lining is heated with wood and coke for three hours and then the charge for the first heat is introduced.

After the first heats have been tapped, the bottom and banks are fettled with fine dry magnesite powder, sintered in by exposure to lowered hot electrodes. Usually after the repair of the bottom, 6-8 heats of carbon steels are carried out by the method of remelting or with a partial oxidation. The furnace is then operated in the ordinary way.

The life of such a bottom constitutes about 2000 heats; in practice, these bottoms can be kept in service for much longer.

The problem of the removal of the old lining, when it has to be replaced, has been successfully solved at our plant. The old lining, which constitutes a single solid mass, is removed by means of ropes 37 mm in diameter. The walls of the furnace and the banks are broken up in the usual way, then a peripheral portion of the bottom is removed, and the bottom is girthed with a rope and heaved out of position. Then another rope is introduced; the nooses of both ropes are hooked to the crane and the bottom is removed in one piece from the furnace. This method of removing the bottom from the furnace is shown in Fig. 5.

This method has resulted in a considerable reduction of the time necessary for the removal of the old bottom (from 6 to 3 days). During the period when the change to the chrome-magnesite roofs was carried out, various types

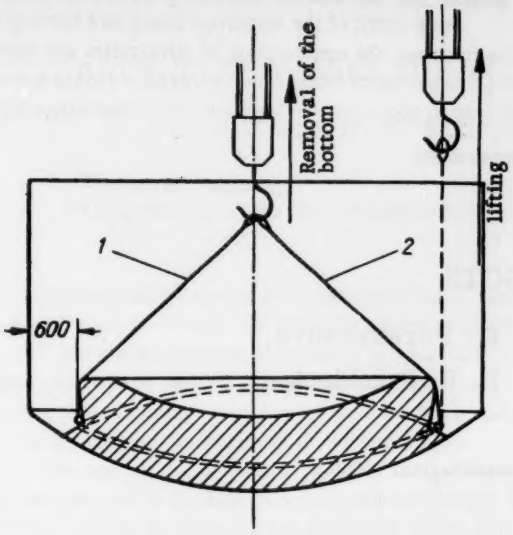

Fig. 5. Method of removing the old hearth bottom from the furnace: 1),2) ropes, 37mm in diameter

of roof construction were tested: mixed roof constructed from chrome-magnesite and Dinas bricks, roof from unfired chrome-magnesite bricks in frames, from fired chrome-magnesite bricks and from heat-resistant chrome-magnesite bricks. The best results, with respect to durability, were obtained with the roof made of heat-resistant chrome-magnesite bricks. The roof is laid on a special cast-iron frame. The frame has a curvature corresponding to the arch rise of the roof, equal to 600 mm. Chamotte base brick is laid close to the metal roof ring. Then the central-roof arch is laid.

The roof is laid of ordinary 300 mm long bricks and of tapering (65-75 mm) 300 mm long bricks. The characteristics of the heat-resistant chrome-magnesite brick are (in brackets are given the corresponding figures for ordinary brick):

Mechanical strength, kg/cm^2 .. 543 (489)
Porosity, % 9.2 (19.4)
Composition
MgO 70.17 (50.45)
Cr_2O_3 ..... 9.45 (20.66)

The supporting arch is laid at 90° to the central arch and then the sectors and partitions are laid. Iron strips 1.5 mm thick are inserted between every two bricks except in the courses which form the openings for the water-cooled ring for the purpose of preventing a burning through. After the roof has been laid the brickwork is made tighter with specially laid locking bricks, and the roof is covered with a 20 mm thick insulating layer of sand mixed with water glass.

In 1954, the life of roofs of heat-resistant chrome-magnesite bricks was 108 heats (the life of Dinas roof did not exceed 40-45 heats). Observations over a long period on the condition of the roof during the operation

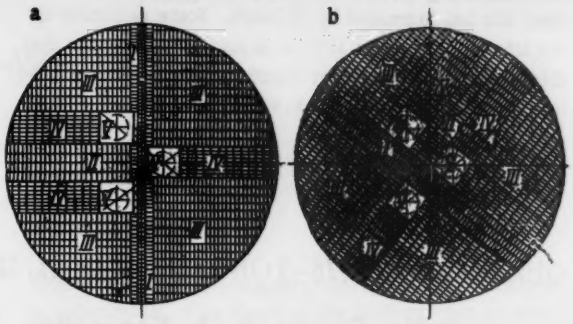

Fig. 6. Methods of laying the roofs of electric furnaces: a) old; b) new; I) central arch; II) supporting arch; III) sectors; IV) partitions; V) openings for water-cooled rings.

TABLE 2. The improvement in the performance of furnaces as the result of improved lining and fettling.

Characteristic	Years				
	1953	1954	1955	1956	1957
Consumption of refractories, kg per ton of steel:					
Dinas	3.5	0.18	0.14	0.11	0.0
Magnesite and chrome magnesite	16.9	14.3	14.1	10.34	8.7
Idle period, % of calendar time*	3.0	2.5	2.10	1.6	1.19

*The time lost on changing the lining of walls and roofs (excluding the idle periods during major and intermediate repairs of the furnace), and the idle periods during the replacement of burn-through water-cooled rings are included (in recent years there have been no hot repairs of furnace linings at all).

showed that the weakest place is the central arch of the roof which did not burn but was damaged owing to its inadequate strength, the great pressure of the supporting arch and frequent changes of the water-cooled rings. On the suggestion of foremen bricklayers, Fudkomaz and Kornilov, the method of the roof layout was changed in 1955 (Fig. 6).

Whereas in the old layout of the roof brickwork the central arch between the openings for the water-cooled rings was 225 mm wide and was under the pressure of four brick courses of the supporting arch, the central arch in the new layout of the roof brickwork is 400 mm wide and is subjected to only a part of the pressure of the supporting arch consisting of three courses of brick. The remaining load of the supporting arch is taken by the brickwork of the opposite sector. In the new layout, the internal boarders of the openings for the rings are positioned at a greater distance from each other and, as a result, the burning through of the water-cooled rings has become less frequent and , consequently, they are changed

less frequently. As a result of the new layout of the roofs their life has increased by 35 heats. Some reduction in the life of the roofs in 1957 is explained by the fact that they were built of ordinary chrome-magnesite bricks and not with heat-resistant bricks which, as has already been pointed out, are best for increasing the life of roofs.

As a result of the improved lining and fettling of the furnaces, the consumption of refractories was reduced, the idle periods of furnaces during repairs were cut down and the repair operations became less labor-consuming (Fig. 2).

QUALITY OF 9.75-TON RAIL-STEEL INGOTS

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Zhdanov Metallurgical Institute and "Azovstal" Metallurgical Works.

With the object of utilizing potential productive capacities and increasing the throughput of the pouring floor of the open-hearth shop at the "Arovstal" Works, the weight of the rail-steel ingot was increased from 6.6 to 9.75 tons.

An extensive investigation was carried out to test the quality of the internal structure and the uniformity of the chemical composition of the heavy ingot. The quality of the steel of the 9.75 ton ingot was evaluated by comparing its characteristics with those of the 6.6-ton ingot; these characteristics were obtained from the sulfur prints of longitudinal specimens, from the macrostructure of transverse specimens (on deep etching), from the variations in the susceptibility to etching in the metal from different parts of the ingot and from the distribution of segregating impurities and nonmetallic inclusions in the ingot.

The study of the macrostructure of the ingot by means of the sulfur prints of longitudinal sections and the deep etching of transverse specimens showed that as far as the physical and chemical nonuniformity is concerned the 9.75-ton ingot of rail steel is equivalent to the 6.6-ton ingot.

The analysis of the distribution of nonmetallic inclusions along the radius of the ingots shows that the maximum content of nonmetallic inclusions is in the central zone of the ingot. A large content of inclusions is also found in the lower part of the ingot. As a result of the investigation, it was noted that the variations in the value of the mechanical properties of the samples taken in the tangential transverse direction are in agreement with the variations in the content of nonmetallic inclusions. The specimens with the maximum content of nonmetallic inclusions have the minimum ultimate tensile strength and, vice versa, the specimens in which the minimum amount of inclusions was detected had the highest ultimate tensile strength.

The amount of nonmetallic inclusions in the ingot is about 0.01% on the average in the skin zone and in the zone of columnar crystals and this amount is, apparently, the same as in liquid steel. On the boundary of the columnar and the nonoriented crystals the inclusions amount to 0.012% in the upper part, 0.013% in the middle part and 0.016% in the lower part of the ingot. In the zone of equiaxial variously oriented crystal the inclusions amount to 0.016% in the lower part and 0.017% on the average in the region of the shrinkage pipe.

A qualitative analysis of the inclusions showed that the well-known rule which states that the size of nonmetallic inclusions increases with the distance from the center of the ingot toward the periphery is valid for the 9.75-ton rail-steel ingot.

The study of chemical nonuniformity of the ingot showed that the extent of the nonuniform distribution of segregating elements in the 9.75 ton ingot is not greater than in the 6.6-ton ingot.

On the basis of the investigations carried out, the following conclusions may be made:

1. As regards physical, structural and chemical nonuniformity, the large (9.75 ton) rail-steel ingot is equivalent to the small (6.6 ton) ingot.

2. The amount of nonmetallic inclusions in the 9.75 ton ingot does not exceed the amount of inclusions in a sound 4.0-ton rail-steel ingot.

3. The mechanical properties of steel in the ingot depend to a high degree on the amount of nonmetallic inclusions in the ingot. An increase in the amount of nonmetallic inclusions lowers the mechanical properties.

4. A large quantity of coarse inclusions of quartz, alumina and the inclusions of the magnetite type are of exogenous origin and their content in steel can be reduced by a more thorough preparation of the runner and the ladle.

BUTTERFLY-TYPE PASSES FOR ROLLING H-BEAMS

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* Senior roll designer
** Roll designer at the rail-structural mill, Kuznetsk Metallurgical Combine

Ordinary flange-passes of closed type (Fig. 1) are used for rolling H-beams. To form the elements of the section, the piece is worked alternately in open and closed parts of the pass. The principle employed in working in the separate elements of the pass determines the design and characteristics of the H-beam pass.

The neck of the pass has a straight-line contour and lies parallel to the line of rolling and the flanges are inclined relative to the neck; the deflection of the internal walls from the vertical does not exceed 2-4% for the roughing passes and 1% for the finishing pass. The inclination or bending-out of the internal walls of the pass is of positive sign for the open flange and of negative for the closed flange. In each subsequent pass, the direction of the taper is changed by the double amount of the bend-out. In this way, during the process of beam rolling, the flanges of the section are subjected in each pass to bending forces of different sign; at the same time, the bending takes place at the joint of the web and flange. From the point of view of the force application, the conditions for changing the direction of the taper are not the same for all passes and depend on the dimensions and the mass of the flanges being bent. In this respect, the most power-consuming are the roughing passes where the deformation of the metal is substantial and the spread between the grooves is considerable. The change in the direction of the taper of the section flange by means of bending the web at the joint with the flanges results in a premature and nonuniform wear of these surfaces (owing to the sliding of the flange edges over the internal surfaces of the closed-pass roll). Therefore, a further increase in the taper of the internal walls in the ordinary pass for rolling H-beams is undesirable. The shape of the H-beam pass in use has several substantial disadvantages:

1. When the rolls are dressed, the width of the pass is not restored because of the small taper of the internal walls. Rolls which are still serviceable as far as their diameter is concerned are rejected as scrap because of the side wear of the passes. Furthermore, the change in the width of the passes after each dressing changes the accepted spread and this complicates the adjustment of the mill and makes the production of constant size section difficult.

2. The small taper of the internal sides of the passes is conducive to the jamming of the piece, it produces considerable frictional forces and intensifies the wear of the passes. The jamming of the piece in the pass has a damaging effect on the functioning of the auxiliary roll equipment and complicates the operation of the mill.

3. The use of an uneconomic pass for rolling H-beams requires frequent roll changes and, hence, the mill output of H-beams (especially of small and medium sizes) is reduced. For the same reason, during the adjustment of the mill after each roll change, there is an excessive amount of rejected material due to faulty contour or incomplete rolling.

With the object of increasing the life of rolls and the output of the mill and of improving the quality of the final product, a new shape of the pass (Fig. 2) for rolling beams of all sizes was developed and adopted. The bending-out of the pass is attained by bending the central part of the web; at the same time,

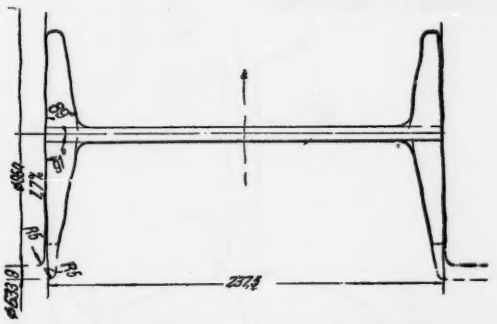

Fig. 1. Ordinary closed-type pass for rolling an H-beam.

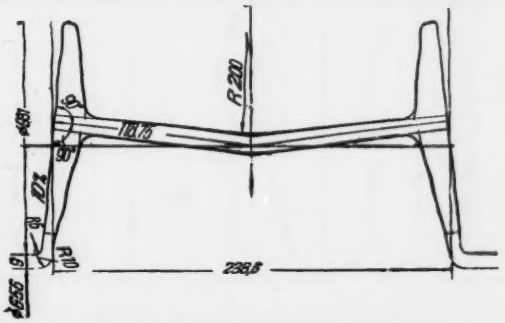

Fig. 2. Butterfly-form pass of closed type for rolling beams.

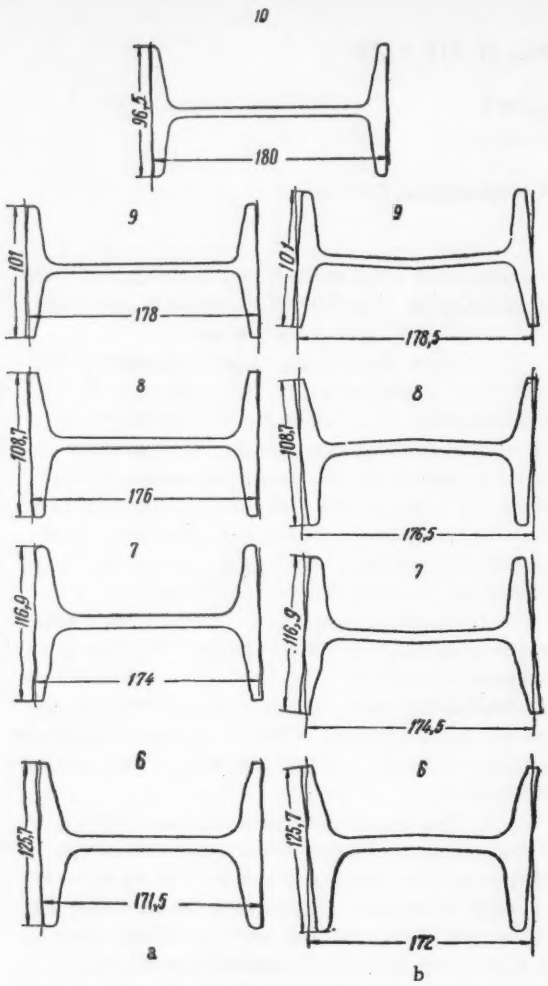

Fig. 3. Final passes for rolling No. 18 beam:
a) ordinary passes; b) butterfly passes 6)-10) passes

the flanges remain perpendicular to the web. The extent of the bending-out depends on the vertical inclination of the flanges and may be brought up to 10%.

The change in the direction of the inclination is effected by straightening out and subsequently bending the middle part of the web. The presence of a "tongue" at the ends of the rolled piece assists in changing the inclination of the flanges without the participation of the sides of the pass, thus wear of the pass sides is prevented.

Beam No.	Mean throughput of a set of rolls in the period between dressings, tons	
	butterfly pass	ordinary pass
18	2170-2250	1380-1770
20	2180-3490	1050
24	2850	2350
30	2020-2800	1170
36	1620-2630	860-900

The butterfly form of the passes for rolling beams increases the life of rolls between dressings and the total throughput of the set of rolls considerably. When the rolls are dressed, the original dimensions of the passes are fully restored and thus the production of a uniform section in the course of the total service life of the roll set is ensured, the jamming of the piece in the pass becomes less frequent and the operation of the auxiliary roll equipment is smoother. Moreover, with the butterfly method of rolling (Fig.3), the diameter of the collars of the open-pass roll increases (depending on the size of the section rolled) to 20mm and this enhances substantially the mechanical strength of the roll in the cross section under the greatest stress. It follows from the actual data that the number of dressings of one set of rolls with the new pass design increased by more than 50% compared with the ordinary rolls. The throughput of the roll in the period between the dressings also increased substantially (Table).

The comparative data, given in the table, on the throughput of the set of rolls of the prefinishing stand confirm the effectiveness of the adoption of new-type passes for rolling H-beams (light-section H-beams in particular).

AN IMPROVEMENT OF THE PASS DESIGN FOR ROLLING R-5 RAILS

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Enakievo Metallurgical Works

R-5 rails (Fig.1) are designated for ground and suspension tracks.

The readjustment of the mill for rolling this section as well as the change from rolling R-5 rails to the production of another section, was carried out without a change of the rolls of the roughing stand; a saving in time was achieved in this way because the roughing and the finishing lines are served by one bridge crane.

The initial arrangement of passes for rolling R-5 rails is shown in Fig. 2.

The billet for R-5 rail (135 mm², 1.35 m long, 237 kg in weight) was rolled in 9 passes in the roughing stand of the rail-structural mill into a square of 55 mm side. It was then delivered to the finishing line where it was rolled in 7 passes (one pass each in stands I, II, IV and V and three passes in stand III).

When R-5 rails were being put into production, it became necessary to increase the taper of the sides of the rail passes from 1.5 to 3% in order to ensure a normal discharge of the piece from the pass. This modification however, did not permit the passes to be fully restored to original design dimensions during the dressing and this was the cause of a one-side undercutting of the rail head in the finishing pass and of nonuniform thickness of the rolled piece.

The adjustment of the mill at the beginning of the rolling, after the change of rolls in any one stand or after the change of passes was very difficult; a large quantity of defective product was usually obtained before the normal rolling process was started.

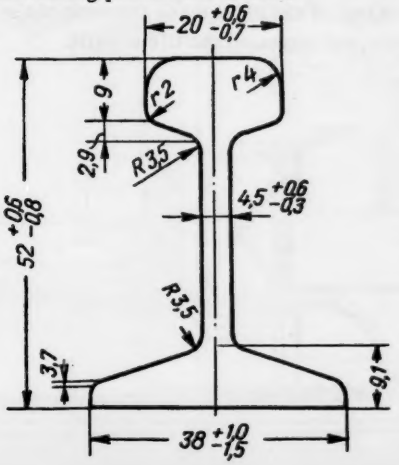
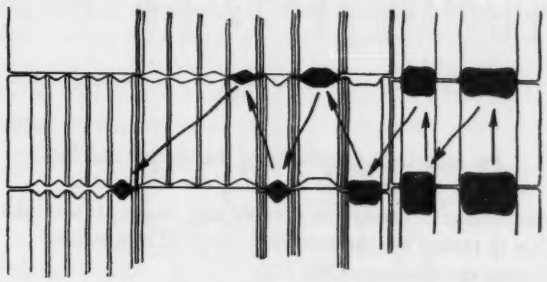


Fig. 1. R-5 rail

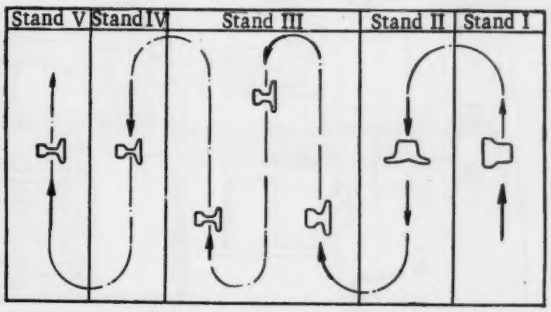
As a shortcoming of this arrangement of passes, one has to mention the placing of two equal passes on the rolls of stand III. Owing to wear, the rolls had to be changed frequently and this caused a decrease in the mill output and an excessive roll consumption.

After the rolling of R-5 rails with this pass arrangement had been mastered, the main hourly output of the mill was 15.57 ton/hr and the rejected product constituted, according to the records of the OTK*, 2.2%.

When the demand for this type of rails increased and the production of R-5 rails had to be expanded, steps were taken to meet the demand. First of all, the pass arrangement was revised and improved, and then a special regime of rail drafts was worked out so that the change of the drafts during the scheduled repairs of the mill would not have a negative effect on the mill output. The adoption of the special draft arrangement entailed the elimination of two passes in the finishing line of the mill. In this way, a "bottleneck" was eliminated (there is only one pass instead of three in the stand III).



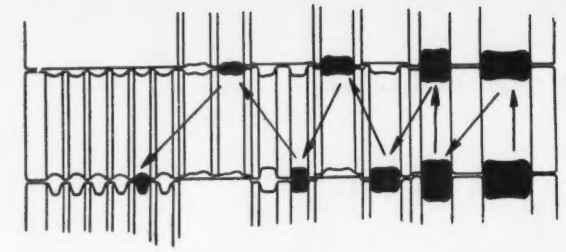
a



b

Fig. 2. Initial arrangement of passes for rolling R-5 rails; a) roughing line; b) finishing line.

*OTK = Technical Control Division



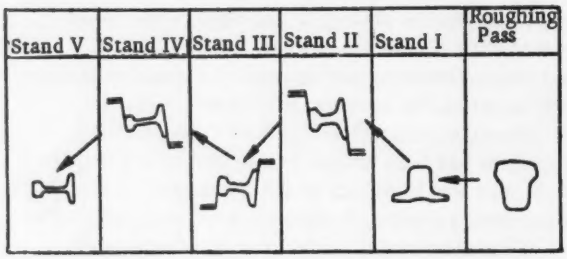


Fig. 3. Improved pass arrangement for rolling R-5 rails; a) special roughing passes; b) finishing line.

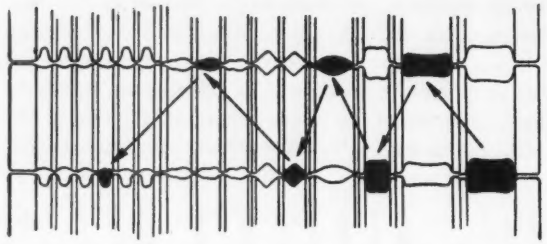


Fig. 4. Seven-pass arrangement of the roughing stand

For ensuring a constancy of the section and facilitating the adjustment of the mill, the diagonal arrangement of passes was adopted and, hence, it was possible to restore all passes to their original dimensions during the dressing of the rolls.

The improved pass arrangement is shown in Fig 3. If the new arrangement is compared with the initial one, it is seen that the number of passes was reduced by eliminating one rail-shaping (there are 4 instead of 5 passes) and one breakdown pass.

In the new pass arrangement, the rolling process in the finishing line is carried out in accordance with the most rational principle for this type of mill: one pass in each stand. With this arrangement, the finishing line can take all the rolled pieces which leave the roughing stand.

After the rolling of R-5 rails with the new pass arrangement had been adopted, the mean hourly output increased by 17%. According to OTK records, rejected product fell from 2.9 to 0.66%.

Owing to the modification in the pass arrangement on the rolls of the stand III and the increased temperature of the steel rolled, the consumption of roll per ton of rails was reduced substantially, except for the rolls of stand II, where the consumption increased owing to the heavy rail-forming pass.

The analysis of the operation of the mill with the new pass arrangement for rolling R-5 rails shows that all the potentialities have not yet been fully utilized. This is true especially with regard to the operation of the special roughing passes. The new arrangement of passes resulted in some difficulties in the work of mill operators at the beginning of the finishing line, the final result being that the finishing line was not charged to its full capacity.

The pass arrangement of the roughing stand was revised and more rational roll design was developed (Fig. 4). Owing to increased drafts, two passes were eliminated and, thus, the mean hourly output of R-5 rails was increased to 20.78 tons/hr. In addition, owing to an appropriate spacing of the grooves on the rolls, it was possible to dress the rolls in sets of four because there were no conjugate grooves.

With the new seven-pass arrangement, the consumption of rolls fell from 10 to 6 rolls per year.

In this way, the improvements in the pass arrangement for rolling R-5 rails contributed to an increased output of the mill, made the work of the operators easier, and increased the life of rolls.

THE OPERATION OF REHEATING FURNACES OF CONTINUOUS MILLS

M. S. Kruskal' and V. V. Getmanets

"Krivorozhstal'" Works

In recent years, side by side with the construction of high-output automated rolling mills, large-capacity reheating furnaces with recuperators began to be extensively adopted.

Figure 1 shows the continuous two-zone reheating furnace designed by the Stal'proekt for continuous rolling mills.

The furnace serves for heating square billets of 80 and 60 mm side, and 11-12 m long. The furnace has an inclined hearth of 180 m^2 area. Mixed gases (blast-furnace and coke-oven) of 1400 kcal/m^3 calorific value are used as fuel.

The gas is fired in 28 injection burners (14 for each zone). A general view of the burner is shown in Fig.2.

The automatic control system of each zone consists of a platinum-platinorhodium thermocouple, an EPP-120 electronic self-recording controlling potentiometer, an IR-130 isodromic regulator and a IMT-6/120 servomotor which changes the position of the gas controlling valve of the burner manifold for the respective heating zones.

The pressure in the furnace is maintained at a preset value by means of a RDM-35 regulator, whose control element operates the throttle-type flue valve which is placed behind the gas recuperator.

The temperature across the furnace in both zones, the temperature of the flue gases in front of and behind the gas recuperator and the temperature of the gas and the air, as well as their pressure, are controlled continuously.

The billets from the receiving grating, which has a stationary and a movable system of rails, are discharged onto the roller tables and then to the roller charger mounted in the corner of the furnace. The roller charger feeds the billet into the furnace at a speed of 2.5 m/sec. The billets are pushed along in the furnace by means of a lever pusher of 42 ton force, with 500 mm lever stroke a and a speed of 0.18 m/sec.

The billets are delivered from the furnace by a rod pusher of 0.9 ton force onto the distributing table. The speed of the pusher rod is 1.5 m/sec.

The billet, partly pushed out of the furnace, is caught by the discharge roller and put between the rolls of the mill.

The design envisaged the automation of the charging and discharging of billets into and from the furnace, within the system of the rolling-speed regulators. This was found to be impossible because of large variations in the curvature and length of the billets, the bending of billets during heating and progress along the furnace, as

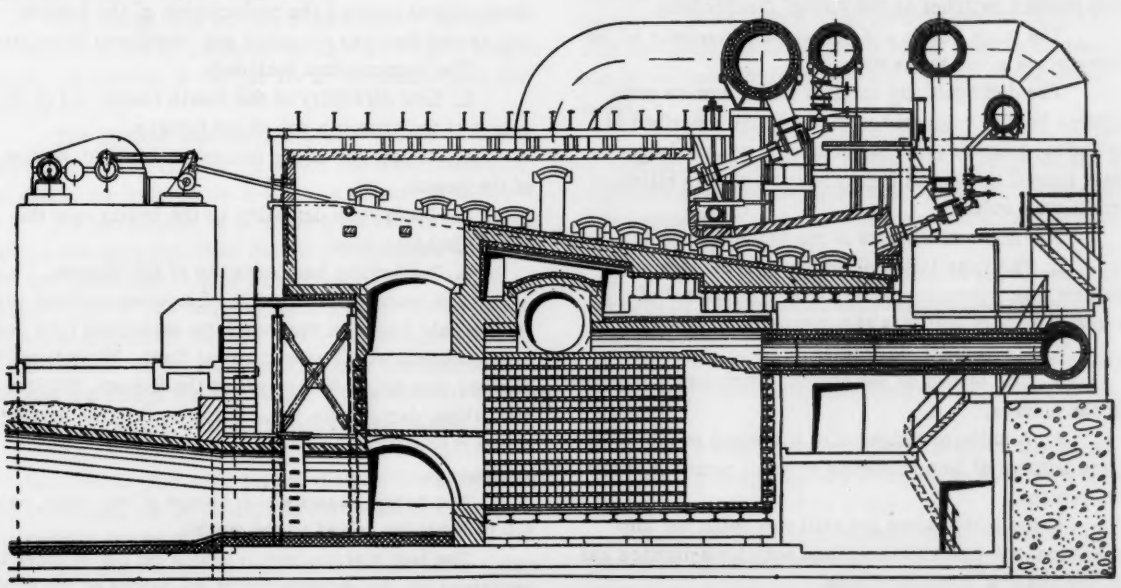


Fig. 1. Continuous two-zone furnace of Stal'proekt design.

Furnace Characteristics

Characteristic	Specification	
	design	actual
Maximum throughput, tons/hr	100-120	95
Mean temperature to which the steel is heated, °C	1140-1180	1120-1160
Heat consumption at maximum throughput, kcal/kg	370	455
Heat output of the furnace, kcal/hr	59	43.2
Dimensions of the furnace:		
width, m	12.57	12.57
length, m	15.0	15.0
hearth area, m^2	188	188
Volume of air checkers, m^3	270	270
Surface area of gas recuperator, m^2	425	425
Temperature of heated up gas, °C	200	180
Temperature of heated up air, °C	500	450-550
Calorific value of fuel, kcal/m^3	1400	960-1400
Temperature in the heating zone, °C	1350	1220
Temperature in the soaking zone, °C	1350	1350
Gas pressure before the furnaces, mm of water	1500	1500

well as the unreliable functioning of the photoelements and pressure switches on the charge mechanisms.

The main design and actual characteristics of the furnace are given in the table.

The distinguishing features of the furnace considered here as compared with the design described in technical journals are: larger throughput and larger heat output; no bottom firing; heating of long billets of small cross section.

The main advantages of the furnace include:

1. The installation of hot gas and air injection burners which provide for the automatic control of a constant ratio of air: gas at a minimum excess air.

2. Convenient slag removal.

3. The billets do not "hump" when they are pushed in the furnace.

4. A uniform temperature is ensured owing to the large number of burners spaced at small intervals across the furnace.

In the period when the mill was being put into operation, the furnaces were fired with blast-furnace gas of 960 kcal/m^3 calorific value.

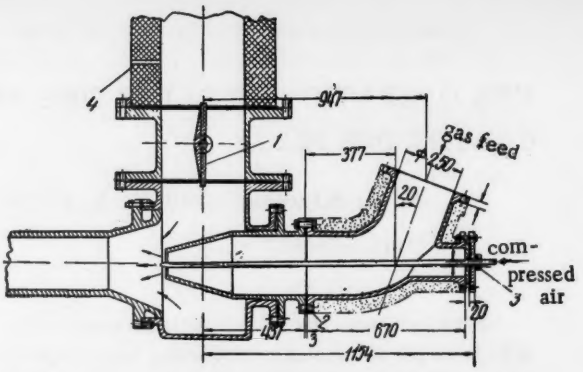


Fig. 2. Injection burner: 1) air throttle; 2) gas nozzle; 3) compressed-air tube, ½ inch in diameter; 4) position where air pressure and air flow rate were measured.

When the furnace was fired with the blast-furnace gas, the jumps of the flame inside the burner body were excluded, the operation of the furnace caused no intense slag formation on the hearth, nor welding together of the billets nor other irregularities at the time when the mill operation was characterized by great variations in the speed of rolling and idle periods in connection with the adjustments of the equipment.

Apart from the above factors, this method of introducing the furnace into operation was dictated by the imperfections in the existing systems of automatic control of the composition of the mixed gas at the mixing station of the Works.

Subsequently, the calorific value of the gas mixture was fixed in relation to the required throughput of the furnace.

Several defects in some design elements of the furnace were detected in the course of operations and these defects lowered the performance of the furnace and caused frequent stoppages and shutdowns for repairs.

The shortcomings included:

1. Low durability of the hearth beams and of the guides at the charging end of the furnace.

2. "Slippage" of the billets on the solid section of the hearth.

3. Inadequate durability of the hearth near the billet discharge door.

4. Inadequate heat capacity of the furnace.

The hearth guides consist of separate sections with fenders laid freely on the transverse supporting tube and brick columns which constitute gas flues. When they are charged, the billets bump against the fenders, displace the guides, damage the brick supports, clog the grating of the recuperators and wear down the water-cooled guides.

The hearth beams which consist of two parts, each 4.5 m long, are joined to the guides.

The fact that the hearth beams get out of order is explained by the deformation of the arches of the brick

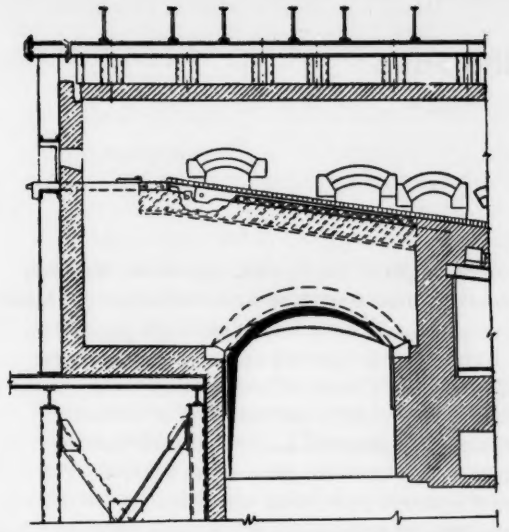


Fig.3. Alteration of the charging end of the furnace.

columns, the absence of rigid fastenings, and the elongation and bending of the beams owing to the fluctuations of temperature over their cross section.

The working part of the hearth in the discharge door opening has no trough and is laid with chrome-magnesite brick. In the course of the movement of the billets and pusher rod, the bricks get eroded and the normal discharge of the billets from the furnace becomes upset.

The large inclination angle of the hearth (8° 15') causes the billets to "slip" in the heating zone of the furnace. An especially serious "slippage" takes place when the temperature in the heating zone is above 1200°C.

The design heat output of the furnace was not attained (see table) although the calorific value, temperature and pressure of the gas are in agreement with the design values.

The defects enumerated above caused frequent shutdowns of the furnace for repair and were conducive to premature breakdowns n of the brickwork parts.

For the purpose of increasing the life of the guides at the charging end, their design was modified and a 13.5m-long water-cooled trough was installed on the central line of the charging door. By this means, it was possible to increase the life of the guides from 1.5-2.0 to 6 months. Owing to its great length and ineffective fixing, the trough was deformed. Therefore, the charging end of the furnace was modified as shown in Fig. 3.

All the sections of the newly installed guides are water cooled. The solid part of the hearth was extended by shortening the gas flues, and the radius of the supporting arches of the gas flues was modified.

All these modifications made it possible to extend the periods between the repairs to one year.

As is known, the main means of increasing the heat output of exsiting furnaces is to raise the gas pressure in front of the burner and to increase the calorific value of the gas mixture coupled with an appropriate reduction of the cross section of the gas nozzles. These variables, however, are limited by the design characteristics of the gas blowers at the boosting station.

An experiment was carried out at the Works with a view to increasing the calorific value of the gases without changing the design of the burners.

The experiment consisted of the following.

A 1/2 inch diameter tube, ending in a nozzle of 3.5-4.0 mm outlet was introduced through the gas nozzle of the burner (Fig 2.). Compressed air 3.0-5.0 atm pressure was blown through the tube.

Measurements of the pressure and flow rate of air were made at a constant flow rate and pressure of the gas before the burner and with fully opened throttle valve in the air feed pipe.

As a result it was found that owing to the additional ejection, the rarefaction in the air-feed pipe increased from 6 to 12 mm of water. At the same time, the air consumption increased by 25-30%, so that it was possible to increase the calorific value of the gas mixture (taking into account the additional cold air supply through the nozzle) to 1800 kcal/m^3.

Hence, according to preliminary calculations, by using compressed air for an additional ejection of hot air from the recuperator, it is possible to increase the heat output of the furnace to $65 \cdot 10^6$ kcal/hr without any constructional modifications.

The application of the above method of increasing the heat output of the furnace is limited by the fact that it is impossible to maintain a constant excess air when the heat output of the furnace is changed.

The design of the Stal'proekt large reheating furnaces now under construction incorporates the most recent technical advances, and a proper heating of steel can be attained in these furnaces with minimum heat losses.

However, for a further improvement in the design of continuous furnaces, an increase in throughput and a reduction in losses due to frequent stoppages for repairs, it is necessary to take the following considerations into account in future designs:

1. To increase the heat output of the furnaces on the basis of the technical capacities of automated continuous mills.

2. To strengthen the construction of the charging end of the furnace with the object of increasing its life to 2 years.

3. To reduce the inclination angle of the hearth.

4. To design burners which could be used for firing gases of various calorific values.

Furthermore, the increased output of modern continuous section mills necessitates a substantial enlargement of the hearth area of the heating furnaces; at these mills at least two furnaces are required.

IMPROVING THE CONDITIONS OF ANNEALING SHEET STEEL IN MUFFLE FURNACES

V. P. Emel'yanov

Magnitogorsk Metallurgical Combine

Piles and coils of thin sheet steel in the cold rolling mill are annealed in muffle furnaces equipped with gas burners mounted along the furnace walls. The combustion products are drawn off by exhaust fans, the suction being more rapid at the walls than at the center. This is due to the fact that there is no apparatus which would control a uniform removal of the combustion products from the whole volume of the furnace.

Since, during the annealing, all burners supply an equal amount of gas, the heating of the steel under the muffle is not uniform owing to the removal of the combustion products. Material which is placed near the walls is heated faster than material in places where the combustion products remain too long.

Because of the nonuniformity of heating, it was necessary to extend the time of annealing in order to attain the required temperature in the furnace, and that reduced the output of the furnace. Moreover, the sheet piles near the furnace walls became overheated and sheets welded together. This resulted in defective production.

With a view to speeding up the annealing operation and attaining a more uniform heating of the metal, a method (proposed by V. N. Tikhonov) of controlling the gas supply by means of shutting off three outside burners at each wall of the furnace was adopted. The furnace is operated under these conditions for 2-3 hours until the required temperature in the center of the furnace is attained, and then the outside burners are fully opened.

The adoption of this procedure considerably improved the heating of metal and speeded up the annealing process and thus resulted in an increased output of the muffle furnaces. After this procedure was adopted, no welded sheets were observed. A substantial saving was achieved.

ORGANIZATION OF PRODUCTION QUALITY CONTROL

I. I. Sergeev and A. I. Khmelik

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In the article "Organization of Production Quality Control" by N. P. Inozemtsev, Ya. I. Sokol, L. F. Rysev, D. A. Tarasenko, and S. I. Zamyatin, published in the Metallurgist No. 9, 1957, the problem of OTK staff reduction and of the increased responsibility of the plant personnel for the quality of production was raised. Herein are published comments on this article.

The control functions with which the OTK personnel and the controllers at the sintering and blast-furnace shops are charged, generally consist of inspection and control of the ore yard, the stock house, the casting machines, the cold pig-iron stock, the grinding operations for limestone and coke, the acceptance of raw materials to the stockhouse bins, the proportioning of the charge when the materials are taken from the bins, the mixing and humidifying of the sinter in mixers, the sintering machines in the sintering section and the delivery of the finished sinter.

In addition to the OTK, the production personnel also carry out the control of the quality of production at all these sections.

A comparison of the organization of technical control at the blast-furnace and sintering plants of some works shows how diverse is the organizational setup of OTK sections (see table)

The number of OTK controllers at the sintering and blast-furnace plants (including internal acceptance operations) was (in the first quarter of 1958): the "Azovstal'" Works – 47 men, the Makeevka Works – 37, the "Zaporozhstal'" Works – 42, the "Krivorozhstal'" Works – 34, the Enakievo Works – 44, the Dzerzhinskii Works – 34.

When the causes of defective and substandard production were analyzed from the records of some blast-furnaces and sintering plants, it was found that there is no direct relation between the increase in defective and substandard production and the reduction in the number of OTK control points.

Interoperational inspection by the OTK at the blast-furnace shops of the above works has, in the main, been abolished and the control operations have been transferred completely to the production personnel. At the sinter plants, however, in spite of a substantial reduction in OTK personnel, the OTK was not relieved from the post-operational control. As a result of a shortage of staff, the OTK could not maintain a systematic control at various sections of the sinter plants (the sections very often being situated quite far apart from each other). Furthermore, the qualifications of the production workers are nowadays considerably higher, as a rule, than those of the OTK controllers who are called upon to check the work of the production personnel when it reaches the postoperational control

Therefore, the OTK controllers cannot give the production personnel effective assistance and, hence, the OTK control is limited mainly to recording already existing defects and irregularities, and does not entail their prevention nor the elimination of any consequences of various irregularities in the production processes.

Furthermore, post-operational control by the OTK tends to make the production personnel regard themselves as free from responsibility for the quality of their work.

It is seen from the information given in the table that the "Zaporozhstal'" and the Dzerzhinskii Works alone have almost completely abolished post-operational control by the OTK at the sintering plant. The fact that at the casting machines at the "Zaporozhstal'" Works there are no OTK controllers at all deserves special attention. Since the end of 1957, the pig iron samples have been taken by the foreman at the casting machines. With this arrangement, not a single complaint was received regarding the pig iron dispatched from storage.

Thus, post-operational control at the sintering plants and the blast-furnace shops should be abolished. The responsibility for the control should be transferred completely to the production personnel who should, as is inherent in their duties, turn out good- quality product only, and, who as far as the qualifications and experience is concerned, are the best controllers in their own production sections.

In our opinion, the control of the finished sinter could be more profitably transferred to the TsZL* and the blast-furnace plant staff (e.g. foremen and shift technicians at the ore yard), and the OTK control should be abolished. The control operation consists essentially of taking sinter samples in accordance with the current instructions at the Works and distributing these samples for chemical and physical tests. The quality of the sinter should satisfy the specifications set out by the blast-furnace operators. These specifications may be different at different works and may vary depending on the operating conditions of the blast furnaces, etc. The

* Central Factory Laboratory

Production section	Production control at the work is effected by					
	Zaporozhstal'	Krivorozhstal'	Makeevka	Enakievo	Stalino	Dzerzhinskii
		Sinter plant				
Crushing of limestone and fuel	Production personnel	Production personnel	OTK	OTK	–	Production personnel
Acceptance of raw materials into the stockhouse bins	the same	the same	Production personnel	OTK	–	the same
Proportioning the charge when the materials are removed from the stockhouse bins	Production personnel and periodic OTK control	Production personnel and OTK	Production personnel and OTK	Production personnel and OTK	–	Production personnel and periodic OTK control
Mixing and humidifying the charge in drum mixers	Production personnel	OTK	Production personnel	Production personnel	–	Production personnel
Sinter machines	the same	Production personnel and OTK	Production personnel and OTK	Production personnel and OTK	–	the same
Delivery of ready sinter	OTK	OTK	OTK	OTK	–	OTK
		Blast furnace plant				
Ore yard and stockhouse	Production personnel	OTK	OTK	Production personnel	OTK	Production personnel
Delivery of raw materials from bins into scale cars	OTK (in 1 shift)	Production personnel	Production personnel	the same	OTK	OTK (in 1 shift)
Casting machines	Production personnel	OTK	OTK	OTK	OTK	OTK
Cold pig iron storage	OTK	OTK	OTK	OTK	OTK	OTK
Taking samples at the tap hole during the pig iron tapping	Production personnel	Production personnel	Production personnel	OTK	Production personnel	OTK

sinter which does not satisfy these specifications is graded as substandard, second grade, etc., and its production is discontinued, but it is used up in the blast furnaces, i.e. it is not an irremediably rejected product. Therefore, the blast furnace personnel should be responsible for sinter quality control and in the case of a deterioration in the sinter quality, the TsZL should be called upon.

However, considering the extreme importance of a correct evaluation of the sinter, this change should be effected gradually, and for the time being, the control and inspection should be left to the OTK.

One must point out that the mechanization of the OTK controllers' operations connected with the determination of production quality by means of sampling is very limited. As a rule, there are neither mechanical samplers nor recording instruments at the proportioning tables for the proportioning of the components of the charge.

In itself, the technique of sampling leaves much to be desired. Thus, at the "Zaporozhstal" Works, the sample consists of large lumps and fines of sinter, while at the Krivoi Rog and the Makeevka Works it consists of large lumps only. The results of the chemical analysis correspond to the quality of the sinter in the sample but the sample inself is not representative of the average chemical composition of the sinter.

Technical imspection of goods received is carried out by the OTK in various manners. At some works, the metallurgical raw materials are checked at the nearest station where they are delivered, and at others – on unloading at the plant where they are to be used.

The essence of the control in both cases consists of checking, by inspecting the appearance of every carload, if the type and quality of the raw materials delivered are in agreement with the description in the accompanying documents made out by the suppliers. At several works, some types of raw materials are sampled for chemical analysis. Complaints are made if there is a discrepancy between the results of the check at the works and the data given by the suppliers. It is considered at the Stalino and some other works that the suppliers' data with respect to large consignments of materials (supplied over long periods of time) are reliable, since any discrepancies in the determination of the quality of the raw material in some carloads or over a short time interval (a day, ten days) cancel themselves out.

There is no OTK control of raw material quality at the Stalino Works and the duties of checking the types and grades of the materials against the suppliers's information in the accompanying documents are placed on the dispatchers of the supply departments.

That this is the correct arrangement is confirmed by the investigations carried out at the Dzerzhinskii and the "Azovstal'" Works, where a regular check on the quality of iron ores is kept by taking test samples. For instance in the period from December, 1957, to May, 1958, (i.e. six months) 73,544 tons of iron ores (lumpy ore, nut ore, sintering ore class 22 and 26) was subjected to check tests. The over-all percentage of iron in the ores tested at the Works was 57.8% according to suppliers' data and 57.8% according to the results obtained at the Works.

Thus, when large quantities are delivered, the data provided by the suppliers are reliable and there is no need to take samples for check tests.

The samples for determining the quality of the raw material should be taken only after the material has been blended and before it enters the production process; this is a production operation and should be done by the production personnel in conjunction with the personnel of the TsZL (Central Works Laboratory).

LETTER TO THE EDITOR

During the whole of the past year, the Metallurgist has been publishing comments on the article by Inozemtsev, Sokol et al. "The organization of production quality control" which has aroused deep interest among many employees at metallurgical works. These articles are particularly valuable since up till now there has been considerable confusion and a lack of coordination with regard to the evaluation of OTK activities and duties.

It seems to us that the most characteristic and correct idea of the majority of the authors can be expressed by the title of N. P. Popov's article (Metallurgist No. 9, 1958): "The OTK controller is a productive worker at the plant".

We, and we hope the majority of workers employed on technical control, are in full agreement with this definition of the OTK controller's activities at the establishments of the iron and steel industry. We fear, however, that in spite of the good material published in the Metallurgist, the ideas presented will remain only recommendations.

In our opinion, several rules should be made official, the duties of the OTK should be unified and some aspects of the labor laws relating to that group of workers should be revised.

In view of the above considerations, we suggest that a conference of the OTK workers of the iron and steel industry should be held with the following tentative agenda:

1. Functions of the OTK at the blast-furnace, steelmaking and steel rolling plants. Rights, duties and labor laws (in particular, to consider the problem of piecework remuneration for the controller on the production line).
2. The technique of present-day defectoscopy and the prospects of its application in the iron and steel industry.
3. Organization of technical control abroad.

If it would be difficult to arrange an All-Union conference, then, at least, several conferences should be

Parshikov, Syroedin, Belichenko, Pinyagin and Krinitsyn. Inspection foremen at the Nizhen-Tagil Metallurgical Combine.

With the above material, we close the publication of articles received by the editor on the problems of the organization of production control at the establishments of the iron and steel industry. The Editor thanks all who have written and hopes that the discussion of this problem in the Metallurgist has been valuable, since it provided an opportunity for making generally known what has been done at works with regard to simplifying the structure and reducing a number of sections in the Departments of Technical Control.

Obviously, the reduction of the staff of the Departments of Technical Control should be continued by means of abolishing inspection operations on various production processes, increasing the responsibility of the production personnel for the quality of the product and introducing further automation and mechanization which would ensure uniformity in the production processes.

When the extent of the production control at an establishment is to be determined, no one standard control system acceptable for all establishments can be recommended. It is essential, in the determination of the extent of production control at a works or a group of works to take into account the qualifications of the personnel, the equipment available at the works and the complexity and designation of the product manufactured.

In consideration of readers' requests, the Editor has approached the NTO* of the iron and steel industry and suggested that a conference of technical personnel of the OTK and iron and steel works on the problems of the organization of the production quality control should be convened. The Presidium of the NTO will in the very near future consider if such a conference is desirable.

Editor

* Scientific and Technical Society

IMPROVEMENTS IN TRANSPORT FACILITIES AT THE CHELYABINSK METALLURGICAL WORKS

S. N. Bystrov and S. A. Sanpiter

Recently, the operations on preparing materials at the Chelyabinsk Metallurgical Works have been considerably improved. The work carried out includes: the mechanization of loading and unloading operations on the main internal transportation; the adoption of schedules and permanent systems for internal and main railroad transport for supplying the plants with basic materials; relieving the internal transport system from loads which could be carried by other means.

With the present system of bottom pouring of steel, the refractory plant dispatches about 4,300 tons of refractories to the open-hearth and electric steelmaking plants every month. Previously, they were transported in closed cars which entailed long standing periods for cars and the use of manual labor on loading and unloading.

At present, all refractories are delivered to plants in special containers, buckets and self-discharging cars. In the design of the containers, the specific conditions existing at each plant were taken into account, so that it was possible to eliminate manual labor on unloading operations.

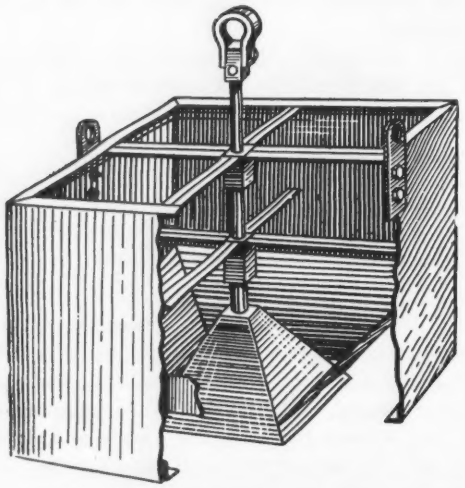


Fig. 1. Bucket for transporting loose materials (lime, coke, mortar).

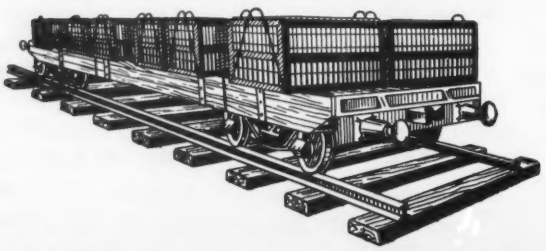


Fig. 2. Transportation of ladle refractories in containers

The buckets (Fig. 1) are used for transporting lime and coke to the electric steelmaking plant and mortar to the open-hearth plant. The loading has been simplified considerably and materials can be discharged directly into the storage bins.

The transportation of ladle refractories in the containers (Fig. 2) to the open-hearth plant eliminated the manual unloading operations in the pouring bay of the plant. Moreover, the manual labor of stacking the bricks in piles and carrying them to the places of work was also eliminated; the bricks are now taken directly to the ladle.

The "cupboard" type container (Fig. 3) for transporting fountain and runner refractories was found to be a particularly useful device.

The containers are of such dimensions and shape that a four-axle flatcar can easily accomodate 6 containers. The containers are of 6-7 ton capacity.

When they arrive at the plant, the loaded containers are taken off the flatcar by means of a bridge crane and put in a place especially allotted for the purpose; from there the containers are taken, whenever required, directly to the places of mold preparation (in the mold preparation plant) or runner (in the electric steelmaking plant). Empty containers are placed on the emptied flat cars and are dispatched to the refractory plant to be loaded again.

Owing to the adoption of these containers, it was possible to eliminate manual operations on unloading the fountain refractories and delivering them to the working places; to improve the working conditions on loading operations at the refractory plant; to eliminate the loss in refractories owing to a sharp decline in fractures. In addition a substantial saving is made on loading and unloading operations, and a reduction in the consumption of fountain and runner refractories is achieved.

The chamotte powder for several plants is delivered in self-discharging cars (Fig. 4) and in MAZ-205 dump trucks. At the plants, the cars are discharged into special bins by means of pneumatic equipment actuated by the locomotives. From the bins, the powder is transferred by means of one-line grab buckets into the bins of the mixing machines and, from there, the ready mixture is dispatched directly to the production sections.

Ferroalloys, which are delivered to the works in railroad cars, were previously discharged either directly at the plants or at the field stores by means of wheelbarrows and mill finishing shop, a mechanized storage of the ferro-

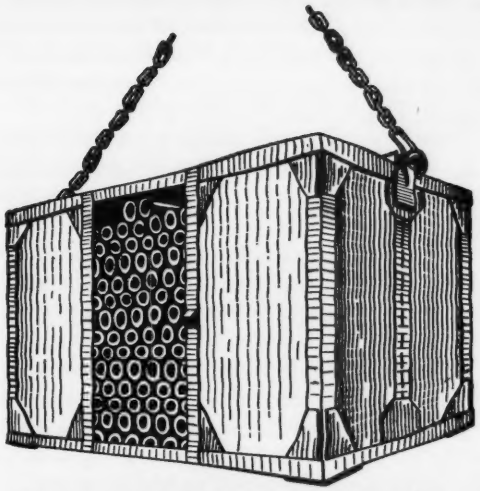


Fig. 3. Container of a "cupboard" type for transporting fountain and runner refractories

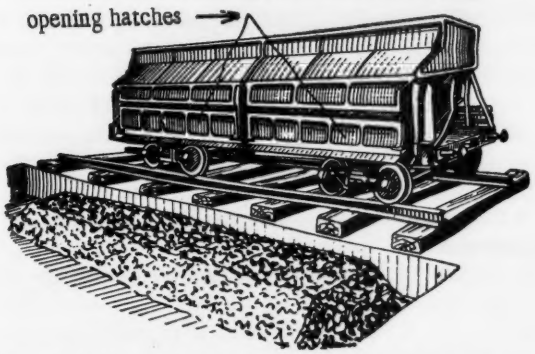


Fig. 4. Self-discharging cars for transporting chamotte powder.

this entailed a considerable expenditure of manual labor. At present, by utilizing the free floor of the blooming-alloys has been set up. There, the ferroalloys, arriving in cars, are discharged into special containers (Fig. 5) and kept in them, and then taken on the flatcars of the local rolling stock to the appropriate plants.

Owing to the adoption of this procedure, the labor consuming operations which involved manual labor for discharging the ferroalloys at the storage place, loading them into the local cars and unloading again at the plants, were eliminated.

The method of delivering other materials to the plants in containers, e.g., lime to the casting machines, sand and clay to the blast furnaces etc., has been adopted at the Works. The delivery of sand in containers to the blast furnaces completely eliminated the manual labor and provided favorable conditions for an uninterrupted supply of sand for the blast furnaces.

The refractory brick for the repair of the open-hearth furnaces is delivered from the store on tray-type containers too (Fig.6) and in this way the unnecessary operations involving manual labor on unloading refractory brick at open-hearth plants and conveying it to the furnaces under

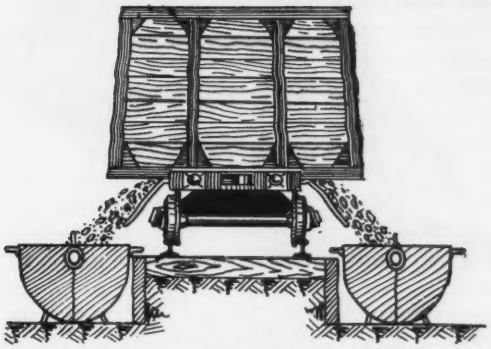


Fig. 5. Method of unloading ferroalloys into special containers.

repair have been eliminated; furthermore, it is now possible to take the refractory, on the trays, directly to the bricklayers by means of bridge cranes.

To improve the supply services of the plants at the Works, basic supply flow lines have been worked out and, for this purpose, a scheme was set up by which the main bulk of loose materials (ore, limestone, bauxite) delivered to the Works in MPS* cars for the steelmaking plants was discharged in the loose-materials section of No. 1 open-hearth furnace. From there, the ore, limestone and bauxite are transported according to a fixed schedule by a local (shuttle) train consisting of five dump cars to other steelmaking plants.

As a rule, the local train carries 3 dump-car loads of ore and 2 dump-car loads of limestone or bauxite (according to the instructions given by the dispatcher of the production department). Thanks to the setting up of a time table for the operation of the local train, the steelmaking plants are adequately supplied with all loose materials in good time.

Special local trains with specially designated locomotives have been introduced to serve the continuous bulk transportation (delivery of the metal to the open-hearth plants, disposal of the open-hearth slag from the slag yard, delivery of the sinter at the sinter plant). The schedules of local train movement give a timetable and the quantities of materials to be carried.

There are also local trains for transporting metal charge to the electric steelmaking plant, metallic additions to the blast-furnace plant, pig iron and blast-furnace silicon to the steelmaking plants and to the foundries, pitch to the open-hearth plants, pig iron scrap to the foundry, coke to the lime-dolomite plant and to the foundry. Special cars have been assigned for transporting various loads which belong to the group of regularly transported materials (ferroalloys, refractories, etc.).

A considerable improvement in the local transport services of the plants was achieved by conveying the materials in containers and self-discharging cars and by assigning a special locomotive to hauling the trains assembled at certain stations at the Works; the movement

* Ministry of Railroads

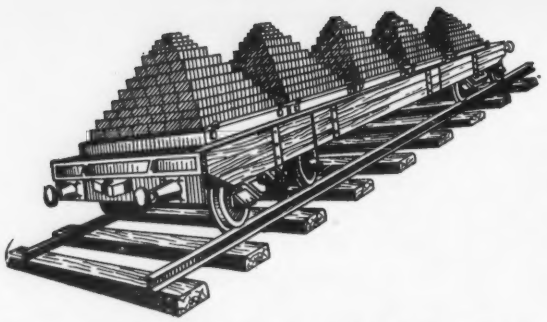


Fig. 6. Transportation of refractory bricks in tray-type containers.

of the assembled trains is kept to a strict timetable. The powerful locomotive specially assigned for this work constitutes a link between the main stations at the Works and makes it possible to maintain the interplant transportation of materials according to schedule and to coordinate the MPS material flow between the scrap, blast-furnace, steelmaking, refractory, foundry, machine, and lime-dolomite plants as well as material and equipment storage yards.

Locomotives, allotted to each station, carry the inter-station traffic of local trains and separate cars.

The dispatchers of the transport service and of the goods traffic service of the railroad plant, as well as the dispatcher of the production department, are responsible for maintaining the movement schedule of the local trains and of the transfer train. They also check the movement of separate cars.

The reduction in the railroad goods traffic owing to the reorganization of the services contributed to a decrease in the volume of goods conveyed and to better supply services for the plants.

In the mold-preparation plant and the electric steelmaking plant, it has been arranged to break the runners down to the required size and to dispatch them to the charging floors of the steelmaking plants.

In the rolling mills, it has been arranged to cut the reject crops and scrap down to the required size so that it is no longer necessary to deliver them to the steelmaking plants via the scrap-preparation plant. Acceptable-size scrap is delivered to the charge yards of the steelmaking plants.

Large amounts of cold pig iron were delivered to the steelmaking plants for conditioning the charge. Owing to the use of carbon-containing additions there is now no need to transport the cold pig iron.

With the object of a further improvement in the transport and preparation of materials a concrete plan of new measures aimed at achieving a still more efficient organization is prepared every quarter at our Works.

WITH OUR FRIENDS

On the invitation of the All-China Federation of the Trade Unions of Heavy Industry, a Soviet trade-union delegation of metallurgy workers made a visit to China recently with the object of exchanging knowledge on trade-union and industrial work.

The Peking Institute of Ferrous Metallurgy, visited by our delegation, was founded in 1952. There are in the Institute 500 professors, lecturers and assistants and 4200 students. By the beginning of the new academic year, there will be 5000 students. 80% of the students have grants; the tuition is free; all students live in halls of residence. The course of studies extends over four years and from the next academic year it will be five years.

The Institute has the following departments: mining, blast-furnace, steelmaking, electric steelmaking, steel rolling, processing, metal working, mechanical, and physical chemistry of metals. The Institute has training laboratories, industrial machine shops and plants where students work; the goods produced help to meet the country's needs. All students have to undergo obligatory physical training in order to keep up with the slogan: "After graduating, every trained specialist should stay in work for at least 50 years".

The graduates are not given a degree in engineering. The degree they receive depends on their work in industry.

The Shitsinshan Metallurgical Works is comprised of the following plants: blast-furnace, sinter, coke-and-by-products and tube casting. In addition, the Works has a power plant, transport plant and other plants. By 1960 it will be expanded: it is envisaged to build a sinter plant, 2 blast-furnaces, three Bessemer converters with provision for oxygen blast from above, a blooming mill, two rolling mills, a tube welding plant and a roll-design shop.

With a view to fulfilling the task set out by the Communist Party of China of catching up with and overtaking Britain in steel production within the next 15 years, the second stage of development envisages the expansion of the production capacities which will result in tripling the output of the Works.

The blast-furnace plant of the Works operates efficiently; the ratio of the useful volume of the furnaces to the daily output constitutes 0.63-0.67; the coke consumption is 690-750 kg per ton of pig iron. These results were achieved owing to the increase in the temperature of the blast to 1060°C. In the very near future, it is intended to increase the blast temperature to 1100°C.

The Taiyuan Works was built in 1937. At present, the Works is comprised of blast furnaces, open-hearth plant and rolling mills including medium, and light-section and sheet mills.

The ratio of blast-furnace useful volume to daily output at this Works was 0.647 for the first quarter of 1958; for April it was 0.620 and 0.523—a record figure; the coke consumption constitutes 620-680 kg per ton of pig iron; the temperature of the blast is 900-960 °C.

The charge was increased at all open-hearth furnaces. In the casting bay, it is not possible to take more than 50 tons of steel into one ladle because of the inadequate strength of the crane girder, and the capacity of the crane and auxiliary equipment. In order to increase the charge, the Chinese operators devised a three-spout tapping of steel into three ladles. In this way, they succeeded in increasing the weight of steel made per heat considerably.

Members of our delegation gave a lecture at the Works to the most active members of the trade union movement in the town on the structure and activities of Soviet trade unions. Our engineers gave lectures on the development of the iron and steel industry in the Soviet Union. On the request of the Chinese hosts, particular consideration was given to such problems as the ways of intensifying the blast-furnace process, the actual effect of applying elevated gas pressure at the furnace top, the use of oxygen in the blast-furnace process, the use of high-alumina and carbon refractories, cooling of the hearth bottom, the intensification of the open-hearth process, Bessemer steelmaking with the use of oxygen, the continuous casting of steel, the vacuum technique, the production of light sections and cold-rolled plate, the use of isotopes in metallurgy, etc..

A talk was held with the steel melters on new techniques and methods in steelmaking processes: the use of basic chrome-magnesite and forsterite refractories in open-hearth furnaces, the increase in the rigidity and temperature of the flame by compressed air and oxygen, the application of optimum thermal loads and high-calorific gas, the increase in draft and the utilization of waste heat by installing waste-heat boilers and a vaporization cooling system; and, specifically, on ways of increasing the output of the open-hearth furnaces at the Taiyuan Works.

The Anshan Metallurgical Combine consists of a blast-furnace plant, an open-hearth furnace plant which has tilting and stationary furnaces, a cogging mill, a rail-structural mill, a tube mill, a plate mill and other plants.

Members of our delegation exchanged views with the Chinese metallurgists on their experiences; together, they discussed the main processes and organization of production: the composition of the charge, the order and method of charging the blast furnace, operating conditions of the blast furnace process, the maintenance of the tap hole when iron is cast 9 times per 24 hrs, the condition of the blast-furnace hearth, methods of preventing the erosion of the hearth bottom and other problems. Our steel melters studied the method of fettling the bottom of open-hearth furnaces. Instead of the existing method of sintering 10 layers in 80-85 hrs to form the bottom, Chinese steel melters use a new method of applying three layers (each 70 mm thick) in 26-30 hrs. The brickwork of the open-hearth furnace roofs consists of magnesite-spinelide brick (85% MgO, 8-10% Al_2O_3). Such a roof on No. 2 furnace has already lasted for 512 heats; the furnace is still in operation and the condition of the roof is satisfactory.

The construction of the Wuhan Metallurgical Combine started in August, 1955. Auxiliary plants, living quarters and internal roads were built in 1956. In 1957, the erection of industrial units — coke-oven batteries and blast furnaces — was started. After the appeal of the Chinese Communist Party to build a great deal, fast, well and economically, the workers employed on the construction decided to complete the first stage of the construction of the Combine in half the scheduled time and at half the estimated cost.

For instance, the bricklaying of the coke-oven battery was scheduled to take 104 days but was completed in 59 days. The equipment of the coke-oven battery was assembled in 10 days instead of 20, etc.

The Wuhan Combine will have the full metallurgical cycle: coke-oven batteries, sintering machines, large blast furnaces, large-capacity open-hearth furnaces, a blooming mill, section mills and other plants.

On September 13, 1958, the first batch of iron was obtained from No.1 blast furnace.

The Chinese people know that they work for themselves, and the task set out by the Communist Party, — "to catch up with and to overtake Britain in industrial output within the next 15 years" — can be completed in an even shorter time. Our Chinese comrades say: "We must work in such a way as to catch up with Britain not in 15 years but to have Britain behind us in 7-8 years".

Yu. V. KHITSENKO

THE SATKA METALLURGICAL WORKS IS NOW TWO HUNDRED YEARS OLD

In November, 1958, the Satka Metallurgical Works celebrated the 200th anniversary of its foundation. To mark this occasion, we publish below the article by the Director of the Satka Works, P. I. Mineev.

In 1753-1759 Baron A. S. Stroganov bought 156,900 dessiatin* of freehold land, plot by plot, from the Bashkir people in the South Urals, for 200 rubles. On November 14, 1756, by the tsar's decree, the Berg Board granted Stoganov permission to erect two iron works on this land near the River Satka.

On November 19, (30 by the Gregorian calendar), 1758, one of the two blast furnaces were built, and three refinery hearths with water-driven hammers for iron refining were put into operation. This date is regarded as the opening day of the Satka iron works.

In 1769, Baron Stroganov sold the works, together with the serf peasants, for 204,000 rubles to a rich Tula merchant, L. I. Luginin.

During the Emel'yan Pugachev uprising the Satka works was one of the first works in the South Urals which joined the insurgents. On December 14, 1773, even before the arrival of Pugachev's insurgents, the new regime was set up at the works. The workers gave a warm welcome to the insurgent detachment under the command of ataman Kuznetsov when it arrived at Satka, and gave him 12 cannons, 250 guns, 5 pud† of gunpowder and 10,000 rubles in cash. A considerable number of workers joined the insurgents. When the uprising was crushed, the Works was ruined and hundreds of workers were killed or missing.

As a result of the bankruptcy of Luginin's descendants, the Works was taken on lease by a Moscow merchant, Knauf, in 1797, and then taken over by the State Bank. By the decree of September 30, 1800, the Works was again given on lease to the merchant, Knauf.

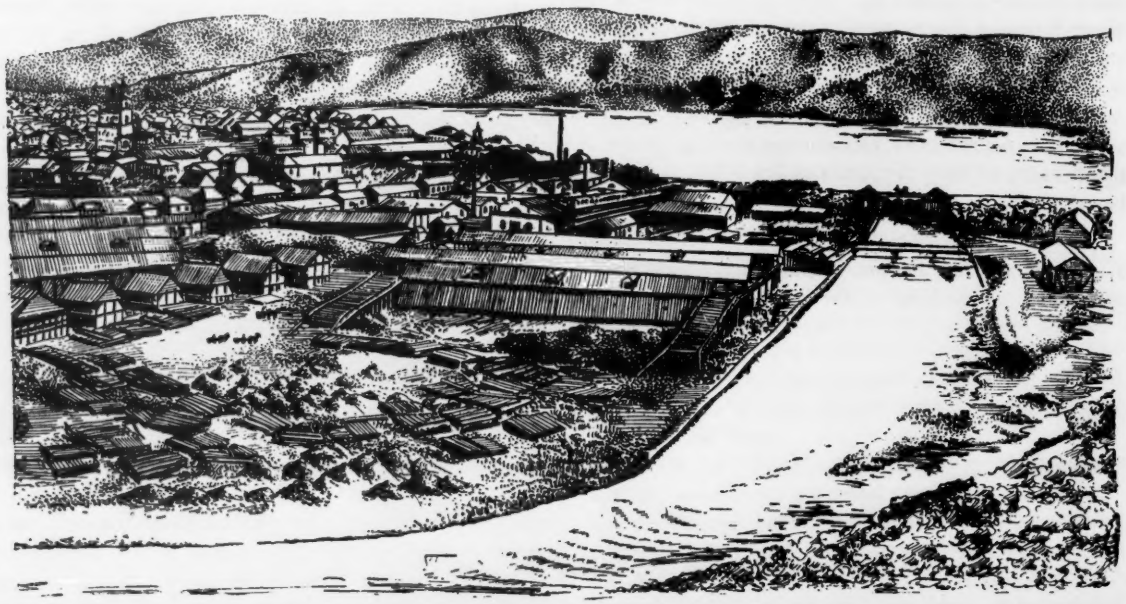
In 1811, the Satka Works was taken over by the State. After that time, it specialized in the production of military supplies.

The main product of the Works was low-phosphorus, quality pig iron. Its output reached 25,000 tons in 1797, but in subsequent years this level did not rise and in some years the production was even far lower; only in 1913 did it increase substantially.

In the pursuit of high profits, the serf-owning proprietors of the Works, and later on the state officials who administered the Works, brutally exploited the workers, without caring about the improvement of working condi-

* 1 dessiatina = 2.7 acres

† 1 pud (pood) = 36.113 US lb.



General view of the Satka Works before 1900

Dwelling houses for the workers in Komsomolskaya street

Output per worker,	Years					
	1913	1917	1941	1945	1950	1957
output in 1913 taken as 100 %	100	75	370	310	516	717
Ratio of the useful volume of the furnace to daily output	2.12	2.39	1.23	1.63	1.00	0.75

tions and production methods. For over 150 years, the Works remained as it was when it was initially built.

Until the Berdyaush-Bakal railroad was built in 1900, all goods were transported in carts: ore from the Bakal mines and charcoal from places up to 35 km from the Works were brought by horses; finished products were also taken away with horses to the Ai river, about 25 km from the Works. The goods were loaded here into special barges and were taken down the Ai, Ufa, Bela, Kama and a Volga rivers, to Nizhni Novgorod.

All production processes were based on manual labor and horse traction. Ore, coal, pig iron, and slag were loaded by hand and transported on wooden-axle carts. Even the charge materials were taken up along a wooden bridge by horses.

The Works was taken over in this state by the working class and it took a long time to re-equip and modernize it, the more so because in the first years of the Soviet rule the Works was not included in the number of industrial establishments which had to be reconstructed.

In 1917, the construction of a 3,000 kw power station and of electric steelmaking furnaces was started at the Satka Works. The power station was put into operation in 1920 and then the electric furnaces were started, but they were soon shut down because the electric power was needed at the Bakal mines.

After a prolonged shutdown period, one of the blast furnaces was blown in on December 20, 1922, and blast furnace No. 2 in 1926. In that year, the prewar output was reached.

During the period of reconstruction and the years of The Five- Year Plans, various section of the Works, in particular the power supply, wood supplies and charcoal firing to provide material for the blast furnaces, were modernized and expanded. While in 1925, the Works had 20 electric motors, in 1958 it had over 500.

In 1935, the wide-gauge rail track was linked to the Works, and four trestles, about 1 km long were erected for unloading ore and fuel. Prior to the erection of the trestles, the ore and coal were unloaded on the other river bank and the limestone was brought from the quarry by horse traction.

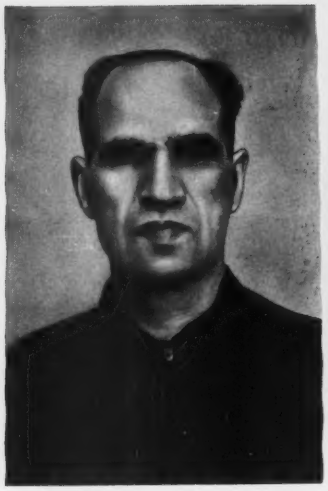
In 1940, No. 1 blast furnace was modernized and the transportation of ore to the elevator was mechanized. The charge materials were delivered to the blast furnace by motorcars and, later on, by electric cars. In 1941, the first casting machine and, later on, a second one were installed; standard slag cars for the disposal of slag were introduced and the railroad track was extended to the blast furnaces.

The arduous work of the tap-hole operators, pig-iron loaders and slag-car loaders began to be taken over by machines. The modernization of the blast-furnace plant made it possible to increase the output of pig iron by a factor of nearly three as compared with the output in 1913.

During the Great Patriotic War, when many workers joined the armed forces to defend their homeland, those remaining at the Works worked with double efforts to increase the output of pig iron.

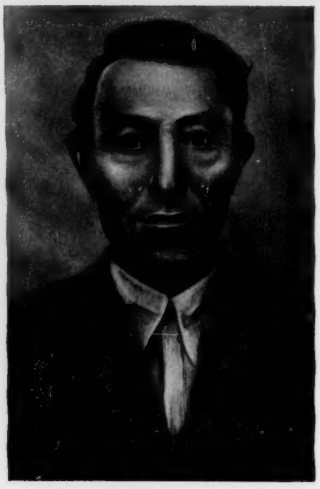
A new blast furnace with all auxiliaries was built economically during the war. It was blown in on September 16, 1944. The whole population of the town took part in the construction work.

Earlier, in 1943, the foundry, which was mainly producing the equipment for the Urals iron and steel works was expanded; tens of thousands of trench stoves for the armed forces were manufactured here.



A. V. Sychev, a fitter at the repair and machine shop.

V. D. Rybenko, first furnace attendant at the blast furnace plant.



N. G. Utrobin, a steel melter at the foundry.

By the beginning of the Second World War, the Satka Works was specializing in the production of low-phosphorus pig iron with the use of charcoal. This pig iron was supplied to munition, armament and tank factories during the whole course of the war.

The depletion of forests and the shortage of labor owing to the mobilization resulted in a decline in charcoal production. From 1942 to 1947, the Works used mixed fuel, and since 1948 coke has been used in all the blast furnaces. However, as there was a great demand for low-phosphorus pig iron, the technical personnel and other employees at the Works worked on developing a method of low-phosphorus pig iron production with the use of coke. Their efforts were successful. By the end of 1947, the first batches of grade B low-phosphorus extra-pure pig iron with a 0.025% phosphorus limit were obtained, and in 1948, the production of grade A pig iron with a 0.020% phosphorus limit from Bakal ore and Kemerovo coke was mastered, including the dephosphorization of pig iron outside the blast furnace, in the ladles, according to a new method.

At present, the Works produces more low-phosphorus pig iron with the use of coke than it did with the use of charcoal before the war. As a result, the Works saves up to 1 million m^3 of wood annually, for wood was previously used for firing charcoal for the production of low-phosphorus pig iron.

The output of the pig iron at the Works during the postwar Five-Year Plans increased owing to the intensification and automation of production processes, the mechanization of labor-consuming operations and the elimination of bottlenecks. At present, all labor-consuming operations at the blast-furnace plant are mechanized.

The rise in operation efficiency and the utilization of the blast furnace as compared with 1913 are illustrated by the figures shown in the table on page 35

During the years of the Soviet rule, the personnel of the Works became a united working team, brought up in the best traditions. The employees at the Works took an active part in the 1917 Revolution and helped in establishing Soviet rule in Satka and neighboring districts.

S. V. Marinin, P. I. Shalyaev, P. Z. Shakhanov, A. F. Solodnikov, I. I. Dudin, E. F. Ershov, P. I. Sesyunin, P. V. Gavrilov, I. G. Sokolov and other workers, who returned home after the civil war, formed a revolutionary nucleus and led the fight for the establishment of Soviet rule. All of them were shot or tortured to death during the counter-revolutionary uprising of Socialist-Revolutionaries in Satka in June, 1918. During the foreign intervention, many workers from Satka fought in the Red Guard and Partisan detachments. A furnace attendant, Vasilii Andreevich Sychev, who volunteered for the Red Army, is now a lieutenant-general in the Soviet army.

Owing to the efforts of the metallurgists at the Works, output is continually increasing. The names of the leading workers, first furnace attendant, V. D. Rybenko, valve operator, I. P. Krokhin, pig iron pourer, V. G. Volkov, fitter, A. V. Sychev, steel melter, N. G. Utrobin, operator of the air blowers, A. P. Krokhin, and of other prominent workers are well known among the Works personnel.

Several veterans who have served the Works for 30 or 40 years have retired and deserve their leisure; these are: blast-furnace foreman, I. F. Nevzorov, furnace attendant, V. Ya. Orlov, valve-operator, F. F. Alpatov, woman-worker, A. G. Golitsina, fitter, L. T. Eretnov, electrician, P. I. Glinin, head of the planning department P. R. Glinin, and many others.

In recent years, well appointed dwellings of 5249m^2 floor area, a Palace of Culture with 515 seats, two shops, a cinema with 330 seats, a school, a kindergarten and 75

The Palace of Culture of Satka workers

separate houses have been built for the workers and technical personnel of the Works.

The character of the Works will never be changed. It will continue the production of high-quality low-phosphorus pig iron. One of the blast furnaces will be modernized and its volume will be enlarged, the expansion of the foundry is envisaged, and a slag-wool plant is to be built. Furnaces for roasting Bakal ores (in particular, siderite) with blast-furnace gas instead of wood will be introduced. This roasting process is essential since the supplies of low-phosphorus brown hematite in Bakal are becoming exhausted and the demand for low-phosphorus pig iron is increasing.

Owing to these steps, it will be possible to increase the output of pig iron by 25%, the output of cast products by a factor of two, and of slag wool by a factor of four.

In 1959-1965, living quarters of 7000 m^2 floor area, a hospital with 50-75 beds, a secondary school for 800 students, a kindergarten for 100 children, and other establishments will be built for the workers. These constructions involve about 20 million rubles expenditure.

The workers are proud of the history of their Works and will go on increasing the output of high-quality pig iron and in this way will contribute to the industrial might of our country.

SOME FEATURES OF PIG IRON PRODUCTION IN CHINA

A. M. Petrichenko and E. A. Sukhodol'skaya

All Soviet people follow with interest the enormous creative work of our Chinese friends who set themselves the great and honorable aim of overtaking Britain in the output of pig iron within the next 15 years. This task is being accomplished by erecting new iron and steel works with most modern equipment, as well as by utilizing extensive experience, accumulated over several thousands of years, on the production of pig iron in China.

At present, in China large metallurgical combines are being built in Wuhan and Paotow. The first blast furnace at the Combine was blown in September, 1958, and the first blast furnace at the Paotow Combine will begin producing pig iron on October 1, 1959—the 10th anniversary of the People's Republic of China. Several medium-sized iron and steel works are under construction and old works are being modernized and expanded. The performance of Chinese blast-furnace operators is very good. A ratio of useful volume to daily output equal to 0.607 was achieved at the blast furnaces of the Anshan Combine, and on May 16, 1958, the personnel of the "Youth Furnace" at the combine in Pengsi achieved a ratio equal to 0.493. Four days later, on May 20, the workers at the Shitsinshan Combine beat the Bensi workers by achieving a ratio of useful volume to daily output equal to 0.488 owing to an elevated temperature of the blast and an improved preparation of the ore and fuel.

At present, the main bulk of pig iron in China is produced at large works. Naturally, it is difficult to obtain a rapid increase in pig iron output by erecting large works, since the construction work requires large capital investments, large quantities of materials, man power and so on. Therefore, the construction of small, "cottage-industry" plants, operated by the old methods are now becoming of great importance. This situation arises from the specific features of the history of the development of the iron industry in China and the distribution of iron ore supplies.

We describe below some old pig iron production methods which are now employed on a large scale all over China.

THE CRUCIBLE METHOD OF PIG IRON PRODUCTION

The old crucible method of smelting pig iron consists first of obtaining a bloom from ore and then converting it to liquid pig iron. There are reasons to believe that the crucible method—one of the oldest methods of making pig iron —has remained unchanged from olden time till the present.

Lean iron ore (35-45% iron) is crushed into particles not more than 20 mm in size and is mixed with the same size coal (1 part coal for 3 parts ore). 20-22 kg of the mixture is placed into special chamotte crucibles (Fig. 1) and heated in a furnace (Fig. 2) to reduce the ore. The furnace is built on a small elevation. It is made of stone and has neither foundations, nor roof, nor front wall. The furnace bottom is covered with a layer of chamotte-crucible chips and a layer of coal; about 300 crucibles are placed inside the furnace, and the space between them are filled with coal. After the furnace has been charged, the side wall is covered with crucible chips and coated with clay; the top of the furnace is also covered with crucible chips. The air for combustion is provided by the natural draft through openings in the lower part of the furnace walls.

During the combustion of coal, the temperature exceeds 1200°C and this ensures an efficient reduction of iron ore which is transformed into sponge iron (sintered bloom iron) ("Ming-T'iek") containing over 75% iron.

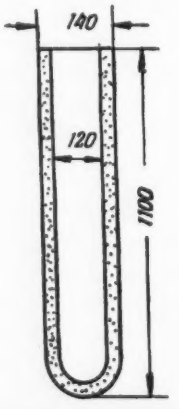


Fig. 1. Crucible

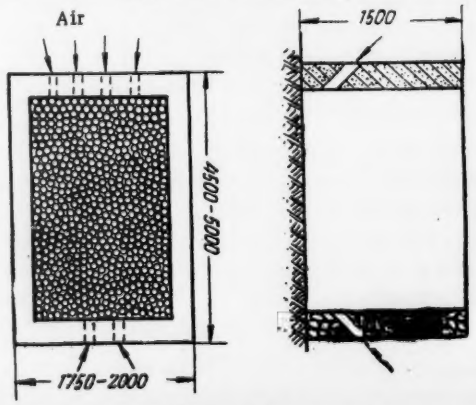


Fig. 2. Furnace for smelting sponge iron

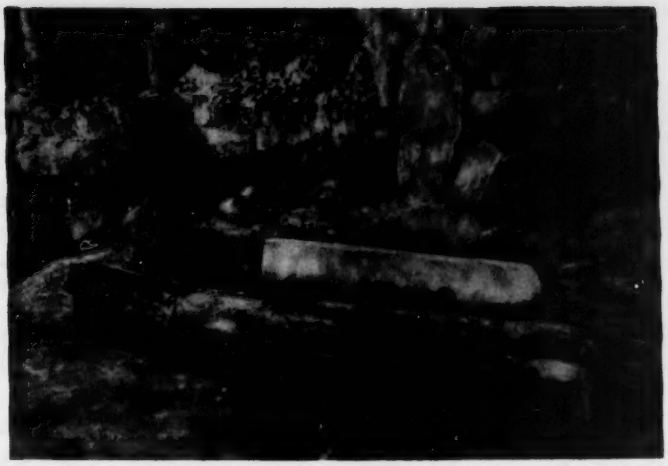


Fig. 3. Crucibles with sponge iron ("bloom-iron")

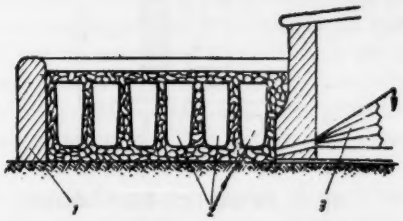


Fig. 4. Furnace for the carburization of sponge iron and the production of pig iron: 1) furnace; 2) crucibles; 3) bellows

One complete cycle of furnace operations, including charging and dis-charging the furnace, takes about three days; the reduction process lasts 24 hrs; coal consumption amounts to about 150% by weight of the sponge iron produced. After the ore has been reduced, the furnace is opened and the crucibles with the sponge iron are taken out. Their lower part is usually damaged but the upper remains intact (Fig. 3). This undamaged portion is used again as an extension for short crucibles.

Finely divided coal is added to the semiproduct obtained and it is charged into new crucibles, 500-600 mm high and 250-300 mm in diameter. Crucibles so prepared are placed in another furnace (Fig. 4) which is of roughly the same design as the first, the only difference being that its walls are lower and the air for combustion is provided by forced draft (usually by means of hand bellows). One heat takes less than 24 hrs. Each crucible then contains 5-10 kg of hot pig iron suitable for castings. The pig iron from 5-6 crucibles is poured into one ladle and cast into molds. In the cooperative establishment which we visited crucible pig iron is used for the manufacutre of food kettles. Fig. 5 shows the method of transferring pig iron from the crucibles to the ladle. Pig iron obtained in this way is sufficiently fluid, and defective kettles with unsound structure or seams are very rare.

PRIMARY SMELTING IN A CUPOLA FURNACE

This method is also a very old one. It consists of two independent operations. The first operation—the production of sponge iron is the same as the first stage of the crucible method; the second operation consists of producing pig iron from sponge iron in small vertical furnaces—Chinese cupola furnaces.

Chinese cupola furnaces were the first furnaces for producing pig iron and, apparently, they appeared much earlier than the old Chinese blast furnaces. The prototype of these cupola furnaces was the old copper smelting furnace. Cupola furnaces are used even now for smelting bronze in some Chinese provinces.

There are several types of Chinese cupola furnaces. Their common features are simple design, a simple method of operating and a single tuyère inclined toward the center of the hearth (Fig. 6). The furnace consists of two or three parts: a spherical hearth and a removable shaft (comprised of one or two truncated cones). The shell of shaft and the hearth is made of steel plates or is cast from iron. Sometimes, the shell is made of strips, reinforced with hoops. The furnace is mounted with its trunnions on a supporting frame and can be tilted for discharging the iron. The total height of these furnaces does not exceed 1500-2000 mm and, hence, the charge materials are introduced directly from ground level (rarely with the use of small platforms). A hand air-blower (Fig. 7) or an electrically driven fan are used for blowing air into the furnace. Sometimes, the air is preheated by means of simple air-heating stoves.

The cost of a furnace in separate various chinese provinces is not much more than 20 yuans. Any cooperative establishment, even in the most remote place can make such a furnace in a very short time with its local resources.

The Chinese cupola furnace may be used for refining pig iron (secondary smelting) or can smelt it from

Fig. 5. Furnace and casting yard

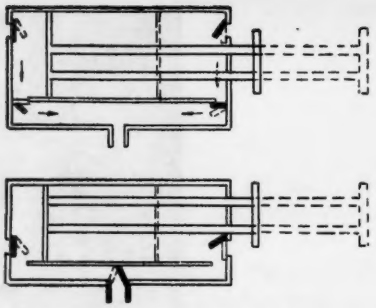


Fig. 7. Diagram showing the operation of hand air-blowers

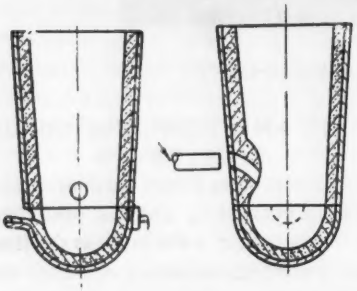


Fig. 6. Chinese cupola furnace

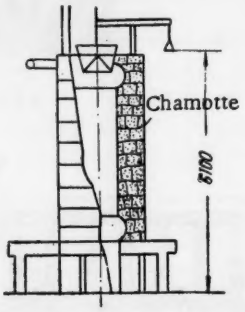


Fig. 8. An old-type blast furnace.

sponge iron. In the latter case, lumps of sponge iron are charged together with coke and lime in the ratio 1:1:0.2 into the furnace. About 1.5 tons of sponge iron is required to obtain 1 ton of pig iron. Since in a low cupola furnace with a small iron-free portion of the charge the carburization of the metal is very small and only very little silicon is reduced in the course of sponge iron production, the pig iron obtained is, as a rule, chilled. Here is the chemical composition of a sample of such a pig iron (analyzed at the Peking Institute of Ferrous Metallurgy), %:

C	Si	Mn	P	S
3,8	0,69	0,04	0,19	0,23

The high sulfur content is due to contamination in the ore and coke.

The structure of the pig iron in castings of about 10 mm thickness cast in green-sand molds consists of pearlite and ledeburite with fine-grained inclusions of graphite. This pig iron is used for various tube castings, cast-iron vessels, and other goods. In view of the simplicity and the very small capital outlay, this method of f pig iron smelting is now becoming extensively employed almost all over China. Metal-processing shops of that type are frequently set up in the open.

OLD — TYPE BLAST FURNACES

The useful volume of old— type blast furnaces is very often 3-4 m^3 only. They are used, similarly to Chinese cupola furnaces, for smelting pig iron not from ore but from sponge iron. A blast furnace in operation in the Shansi province is shown in Fig. 8. It is a vertical, cylinder-shaped furnace, about 6 m high, with a cast iron shell consisting usually of a few thin cylindrical castings, and with a bell-type charging apparatus. There are many furnaces which are charged by hand.

Two cylindrical tuyeres for the hot air which is heated in a special recuperator with cast-iron tubes are mounted in the lower part of the furnace. The furnace and the recuperator are repaired once a month. The shaft and the hearth are usually lined with material obtained locally. The charge for the furnace of 4 m^3 consists of 60 kg of sponge iron, 50 kg of coke, and 30 kg of lime. About 150-160 charges are processed in 24 hrs. The mean residence time of the charge in the furnace is about 5 hrs. from 1 ton of sponge iron one obtains about 800 kg of pig iron which is tapped 7-8 times in 24 hrs, one ton at a time. If necessary, pig iron can be cast in smaller batches. About 700 kg of slag per one ton of pig iron is produced and it is discharged from the furnace through the slag notch.

Up to the present, the old—type blast furnaces have been less common in use than the cupola furnace. This is due, apparently, to the fact that their erection requires larger capital outlay, as well as machines and special equipment. The old-type furnaces, however, have several important advantages: a low ratio of useful volume to daily output (0.6-0.65) and small iron losses in the slag.

The pig iron obtained from the old-type blast furnaces is suitable not only for refining in the cupola furnace but

also for direct pouring into molds. Its chemical composition is, %:

C	Si	Mn	P	S
4,0	0,77	0,13	0,20	0,01

Since productive efficiency of the old-type furnaces is higher than that of cupola furnaces, more attention is now being paid to the construction of old-type blast furnaces.

DWARF BLAST FURNACES

In addition to the large blast furnaces, small dwarf furnaces of 10-250 m^3 volume are very extensively employed in China. The expediency of using these furnaces has been tested by many-years experience and was thoroughly discussed and justified at one of the sessions of the Advisory Council of the People's Republic of China in 1957. The expediency of these furnaces arises from the fact that most of the provinces have enormous supplies of iron ore in the form of small scattered deposits which cannot be utilized economically by large works. The only way to utilize these iron supplies is by building small blast furnaces directly at the ore fields. In addition, in the opinion of our Chinese comrades, the dwarf blast furnace serves as one of the sources for socialist economic growth. The capital outlay on this type of iron industry is recovered more quickly than in light industry. There is, also, an inexhaustible demand for metal consumer goods on the home market. Hardly any expenditure from the state budget is required for the construction of dwarf furnaces as the majority of them are built with local resources. And, finally one should take into account the fact that the dwarf blast furnaces make it possible to provide full employment for the country's population.

Of course, small blast furnaces are less economic than large ones. However, by introducing these furnaces it is possible to increase the country's output of pig iron quickly and effectively without large expenditure. Although the small furnaces are built with local materials, the life of th e hearth reaches 1-1,5 years and of the shaft up to 10 years.

The extent of small blast furnace construction in China is truly enormous. In the first half of 1958, nearly 1000 local small iron works were under construction in Hopeh, Anhwei, Honan, Shantung and other provinces. The whole nation became engaged in building the local iron industry. Even in the distant Wuhu region, in the Kansu province and other districts, where no pig iron production was ever known before, hundreds of small blast furnaces were built in 1958.

300 small blast furnaces and 2000 works with Chinese cupola furnaces for the primary smelting of pig iron have been built in the Hunan province. By the "small" iron industry alone the output of pig iron in this province was to increase by a factor of 9 in 1958.

In all, the number of small iron works built in 1958 or still under construction is 350,000.

All iron workshops and small works are built in accordance with well developed designs, within a definite system and with a wise distribution of technical manpower and resources. Thus, in the Shansi province, blast furnaces of 30-180 m^3 are built by the provincial management, and furnaces of 3-13 m^3 are built by the district industrial departments under the technical supervision of the provincial industrial management. The old-type blast furnaces are built by the domestic-industry cooperatives under the technical supervision of appropriate cooperative organs. Those who are building the furnaces are greatly assisted in technical guidance and directly in the erection work by experts from universities, ministries and other establishments as well as by university students.

The building of the local iron industry in China is a striking example of the inexhaustible potentialities of a free nation which has taken its destiny into its own hands.

THE EDITOR OF "METALLURGIST"

announces the 2nd open compition for the best photograph

Subject: views of works, and plants of the iron and steel industry, new machines, photographs of innovators as well as photographs from the work and leisure of iron steel workers.

Two copies of the photographs should be submitted, on gloss paper 24 x 30 cm (22 x 27 cm picture, 1 cm white margin). A text with a detailed description of the picture place and time must be attached. The photographs should be vertical.

The following prizes will be awarded:

One first	1000	rubles
Two seconds	500	rubles each
Five thirds	300	rubles each

Apart from the prize-winning photographs, the photographs commended by the jury will also be published in the Journal.

The last date for sending the photographs is May 1, 1959.

The photographs, in a stiff cover marked "Competition", should be sent to:

Moscow, G-34, 2nd Obydenskii per., 14
The Editor of "Metallurgist".

A. I. Nikitin and V. S. Arbuzov. Sintering Iron Ores.
Moscow, Metallurgizdat, 1957, 196 p.

"Sintering Iron Ores" by A. I. Nikitin and V. A. Arbuzov is a valuable manual for workers and foremen at sinter plants.

The first chapter of the book contains a short history of the development of the sintering process in the USSR and abroad; a description of the types of sintering machines, their development and improvements in the flowsheets of sinter plants.

The design of the sinter plants containing continuous sinter machines is described in the second chapter. The flowsheets of plants which process raw or beneficiated ore are given and the construction and operation of separate parts of the plant are described.

The third chapter contains a description of sinter machines, auxiliaries and rules regarding the maintenance of the sinter machines.

The fourth chapter is devoted to a description of the properties of raw materials and their preparation for the sintering process.

In the fifth chapter of the book, the authors describe the sintering process, the preparation of the charge, the method of calculating the composition of the charge, the phenomenon of segregation and how to prevent it, the process of mixing and humidifying the charge, and the gas permeability of the charge.

In the sixth chapter entitled "Recent advances in sintering technique", the authors describe methods of speeding up the sintering process with lime or limestone in the charge by means of heating the charge before sintering and by increasing the rate of air flow through the sintering bed.

The seventh chapter of the book contains a short discussion of the problems concerning the organization of the work and safety measures at sinter plants, and the eight chapter contains some operating statistics of the sinter industry.

The illustrations help the reader to assimilate the material presented.

However, the book is not free of some defects.

1. The minimum training syllabus for sinter-plant workers includes the principles of blast-furnace production. There is no chapter on this subject in the book.

2. It is apparent that the book was written some time ago as the information on existing plants is out of date. For instance, the output of the Kamysh-Burun sinter plant is given as 53.11 tons/hr, whereas as early as 1956 it was 64-65 tons/hr on the average. The blame for this defect in the book rests with the publishers.

3. For the same reason, several recent innovations (design and operation of sinter machines of 75 m^2 sintering area, the design of machines of 200 m^2 area etc.) have not been mentioned.

No account of the advanced techniques of sinter-machine operators is given.

In spite of these serious shortcomings, this is a very good textbook for the education of workers and foremen of sinter plants and blast-furnace plants. It is unfortunate that such an inadequate number of copies (3000) has been printed. We hope that a revised and enlarged second edition of this valuable textbook will appear in the near future.

S. Ya. Soboleva,
Manager, Technical Library of the Kamysh-Burun Iron-Ore Combine

Yu. M. Chizhikov. Rolled Steel Production.
Moscow, Metallurgizdat, 1958, 612p.

This is the second, revised and enlarged, edition of the book. It contains the principles of the theory of plastic deformation and the process and method of steel rolling; the method of the evaluation of the work of rolling; an account of the theory and practice of roll design; the tolerances in steel rolling; a description of the range of sections rolled, a description of heating and cooling processes of steel, the preparation of steel for rolling, the methods of process control, etc.

The author describes the process of producing the main types of rolled products (blooms, slabs, H-beams, channels, plates, tubes, etc.) and the methods of calculating the output of rolling mills; he discusses specific features of the process of rolling alloy and high-alloy steels, non-ferrous and rare metals. The operating statistics of rolled-steel production and some data on the design of the rolling mill are also given.

The bibliography of steel rolling and a subject index is included.

The book is intended as a manual for metallurgical technical schools and may be useful for university students as well as for engineers and technicians concerned with metal working by rolling.

The "Inventor and Innovator", a monthly journal, is the organ of the All-Union Society of Inventors and Innovators.

The purpose of the journal is to promote a general development of the innovation movement, to attract the creative thoughts of workers to the problems of improving the organization of work and perfecting techniques, as well as to assist in the introduction of new scientific and technical achievements into industry.

The journal provided information on the activities of the All-Union Society of Inventors and Innovators and its local branches. Considerable space is devoted to problems related to technical progress; information on the most important inventions, profiles of innovators, and articles on invention laws are published. Comprehensive information on foreign inventions is also contained in the journal.

The main part of issue No. 1 for 1959, is devoted to the Twenty-first Congress of the CPSU: there are articles by inventors and innovators who relate their achievement to mark the Congress; an article "Between Two Congresses" by the First Secretary of the Kemerovo Town Committee of the CPSU, Comrade Karpov; an article on the assistance given to the All-Union Society of Inventors and Innovators by the Party, and other material. In addition, the journal contains articles on the activities of BRIZ*, profiles of Comrades Sinel'nikov, Borin, and Chmelova, accounts for a number of Soviet and foreign inventions, and advisory notes on legal problems "Inventor's Diary" is also contained in the Journal.

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*Office for Promotion of Industrial Efficiency and Inventions.

SIGNIFICANCE OF ABBREVIATIONS MOST FREQUENTLY ENCOUNTERED IN SOVIET PERIODICALS

FIAN	Phys. Inst. Acad. Sci. USSR.
GDI	Water Power Inst.
GITI	State Sci.-Tech. Press
GITTL	State Tech. and Theor. Lit. Press
GONTI	State United Sci.-Tech. Press
Gosénergoizdat	State Power Engr. Press
Goskhimizdat	State Chem. Press
GOST	All-Union State Standard
GTTI	State Tech. and Theor. Lit. Press
IL	Foreign Lit. Press
ISN (Izd. Sov. Nauk)	Soviet Science Press
Izd. AN SSSR	Acad. Sci. USSR Press
Izd. MGU	Moscow State Univ. Press
LÉIIZhT	Leningrad Power Inst. of Railroad Engineering
LÉT	Leningrad Elec. Engr. School
LÉTI	Leningrad Electrotechnical Inst.
LÉTIIZhT	Leningrad Electrical Engineering Research Inst. of Railroad Engr.
Mashgiz	State Sci.-Tech. Press for Machine Construction Lit.
MÉP	Ministry of Electrotechnical Industry
MÉS	Ministry of Electrical Power Plants
MÉSÉP	Ministry of Electrical Power Plants and the Electrical Industry
MGU	Moscow State Univ.
MKhTi	Moscow Inst. Chem. Tech.
MOPI	Moscow Regional Pedagogical Inst.
MSP	Ministry of Industrial Construction
NIIZVUKSZAPIOI	Scientific Research Inst. of Sound Recording
NIKFI	Sci. Inst. of Modern Motion Picture Photography
ONTI	United Sci.-Tech. Press
OTI	Division of Technical Information
OTN	Div. Tech. Sci.
Stroiizdat	Construction Press
TOÉ	Association of Power Engineers
TsKTI	Central Research Inst. for Boilers and Turbines
TsNIÉL	Central Scientific Research Elec. Engr. Lab.
TsNIÉL-MÉS	Central Scientific Research Elec. Engr. Lab.-Ministry of Electric Power Plants
TsVTI	Central Office of Economic Information
UF	Ural Branch
VIÉSKh	All-Union Inst. of Rural Elec. Power Stations
VNIIM	All-Union Scientific Research Inst. of Meteorology
VNIIZhDT	All-Union Scientific Research Inst. of Railroad Engineering
VTI	All-Union Thermotech. Inst.
VZÉI	All-Union Power Correspondence Inst.

Note: Abbreviations not on this list and not explained in the translation have been transliterated, no further information about their significance being available to us – Publisher.